

[Claims]

[Claim 1] A route search guide device mounted on a vehicle for performing a route search using a current location information of the vehicle output by a own-vehicle location computation unit or an input location information, and a destination information based on the location information and the destination information so as to perform a guidance based on the route search, the route search guide device comprising:

a map information storage unit being multi-layered, the map information storage unit including an electronic map information covering more detailed road information toward lower layers;

a guide route search unit for searching a route, using a map information in a lower layer in the map information storage unit, for a vicinity of one of a starting location and a destination and for searching a route, using a map information in an upper layer in the map information storage unit, for a location other than the starting location and the destination;

a course change location extraction unit for specifying a traveling direction of a guide route searched by the guide route search unit and a course change location, road types being changed at the course change location; and

a detour route search unit for searching a vicinity of the course change location using a map information in a lower layer and using the guide route when a newly-extracted search result is the same as the guide route and using the newly-extracted search result as a detour route when the newly-extracted search result is different from

the guide route.

[Claim 2] A route search guide device according to claim 1, comprising a route storage unit for storing an information on the detour route as data including a node information indicating an intersection of a road and a link information indicating a route.

[Claim 3] A route search guide device according to claim 2, wherein when the course change location specified by the course change location extraction unit matches a course change location of the detour route stored in the route storage unit, the detour route is reflected on the search of the guide route.

[Claim 4] A route search guide device according to claim 1 or 2, comprising an external storage medium for storing the information of the detour route, wherein the medium is mountable.

[Claim 5] A route search guide device according to claim 4, the information of the detour route read from the external storage medium can be reflected on a guide route search together with other detour route information stored in the route storage unit.

[Claim 6] A route search guide device according to claim 5, wherein when the information of the detour route is read from the external storage medium, a structure, style and form thereof is checked for consistency with those of map information data included in the map information storage unit and then the information of the detour route is stored in the route storage unit.

[Claim 7] A route search guide device according to claim 1 or 2 wherein, comprising:

a camera device for obtaining an information of a traffic signal;

a traffic signal recognition unit for obtaining and recognizing an information of a signal of the traffic signal; and

the detour route search unit for performing a detour route search using an installation location of the traffic signal as a course change location.

[Claim 8] A route search guide device according to claim 7, causing the camera device or the traffic signal recognition unit to operate and comprising the detour route search unit for performing a detour route search when a traffic signal flag data indicating a traffic signal at a node indicating an intersection at a distance specified from a current location is only present in map information data of the map information storage unit.

[Claim 9] A route search guide device according to claim 1 or 2, comprising switching means for obtaining an information of a traffic signal or a road traffic information and recognizing and determining a traffic situation of a route traveled by the vehicle so as to switch a route search from a guide route search to a detour route search.

[Claim 10] A route search guide device according to any one of claims 2, 3, 4, 7 and 9, comprising:

a display unit for displaying a detour route information stored in the route storage unit as a list,

wherein

the display unit displays the list together with a map of the detour route.

[Claim 11] A route search guide device according to claim 10, wherein an unnecessary route information can be selected from the list of the detour route information output to the display unit and the necessary information can be deleted from the route storage unit.

[Claim 12] A route search guide device according to any one of claims 1, 2, 3, 4, 7 and 9, wherein the detour route is displayed together with the guide route.

[Claim 13] A route search guide device according to claim 12, wherein the detour route is distinguishably displayed from the guide route.

[Claim 14] A route search guide device according to any one of claims 1, 2, 4, 7 and 9, wherein a regulation information including road types, grades, road widths and passable hours of the detour route is output to a display unit together with the detour route.

[Claim 15] A route search guide device according to any one of claims 1, 2, 4, 7 and 9, wherein when the guide route and the detour route are simultaneously displayed, the detour route is displayed with a recognizable scale irrespective of a displayed scale of the guide route.

[Claim 16] A route search guide device according to any one of claims 1, 2, 4, 7 and 9, wherein when the guide route and the detour route are simultaneously displayed, once the

vehicle has reached a point by a distance set away from a divergence point to the detour route, the presence of the detour route is displayed on a screen so as to give notice.

[Claim 17] A route search guide device according to any one of claims 1, 2, 4, 7 and 9, wherein once the vehicle has reached the point by the distance set away from the divergence point to the detour route, the presence of the detour route is notified by voice.

[Claim 18] A route search guide device according to any one of claims 1, 2, 4, 7 and 9, wherein when the guide route and the detour route are simultaneously displayed, a segment of the guide route is replaced with a corresponding segment of the detour route, and the detour route is displayed with priority.

[Claim 19] A route search guide device according to claim 18, wherein when the segment of the guide route is replaced with the corresponding segment of the detour route, the replacing detour route is distinguishably displayed from the guide route.

[Claim 20] A route search guide method, comprising the steps of:

- performing a route search based on an input of a current location of a vehicle or a starting location and a destination so as to compute a guide route;

- extracting a traveling direction and a location, at which road types and grades are changed, from an information of the computed guide route; and

- adding a weight to a link cost of a generated route result within a set distance range at a course change

location and performing a route search using road map information data in a lower layer so as to compute a detour route.

[Detailed Description of the Present Invention]

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[Technical Field of the Present Invention]

The present invention relates to a vehicle-mounted route search guide device and, more particularly, to a vehicle-mounted route search guide device that executes searches based on hierarchically prepared map information data and computes guide routes in providing output.

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[Conventional Technology]

Conventionally, route search guide devices are designed to obtain the current location of a vehicle traveling on a road by processing data collected using a GPS (Global Positioning System) or the like by means of a computing device. One of the following is computed to identify a route: (1) the shortest road distance from the current location, (2) from a starting location indicated by the user, to the destination indicated as a point of choice, or (3) the shortest travel time in relation to road type and road distance, and the result is output as the guide route. Figure 22 shows a screen sample showing the result of a search by way of output indicating guide routes (R1, R2) on the display unit of a route search guide device.

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Moreover, maps in the form of electronically prepared data are employed with the aim of reducing the time taken to run a route search. These maps are used as a hierarchical map

database in which map information is arranged in layers with its upper layer, for example, covering high-grade roads such as highways and national roads while the lower layer, for example, covering not only highways and national roads but also prefectural and principal provincial roads. When executing a search, in an area near the starting location or the destination, the map information of the lower layer will be used for full computation while, midway on a route, the map information of the upper layer will be used to make an approximate computation, ultimately integrating the results of both to provide output in the form of a guide route. Neither the map information of the upper layer nor that of the lower layer constitutes a single layer independent of the other and, moreover, the content of each is further grouped into multiple layers, with the map database as a whole usually consisting of 3 or 4 layers. (Example: Japanese Laid-Open Publication No. 3-230299)

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[Problems to Be Solved by the Present Invention]

The conventional route search guide devices, however, present the following problems: for a midway area of a route, the route computation is performed using map information in the upper layer not covering low-grade roads such as prefectural roads and principal provincial roads. Therefore, as a result, there is a problem of the upper layer such as a national road being output, and regardless that there is a route that is shorter than going through low-grade roads such as prefectural roads or principal provincial roads, best guide routes are not provided to the users.

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Moreover, when the output guide route proves to be appreciably congested, the user has the choice of displaying an electronically prepared map of the area on the route search guide device or referring to a paper map directly, possibly locating a detour himself/herself and, at the same time, deviating from the guide route, which will likely necessitate the use of a rerouting function (i.e., a function that searches for a new route from the current location to a point of convergence with the nearest guide route). In such a case, the route search guide device needs some time after the current location of the vehicle has deviated from the guide route in order to recognize the deviation, and thus, incapable of giving smooth instruction and guidance.

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The present invention has been made with a view to solving these aforementioned problems, and it has the object of providing a route search guide device capable of offering the user a guide route that includes detour routes in advance by executing searches through the use of detailed maps for midway points of a route.

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A route search guide device according to the present invention has a structure being mounted on a vehicle for performing a route search using a current location information of the vehicle output by a own-vehicle location computation unit or an input location information, and a destination information based on the location information and the destination information so as to perform a guidance based on the route search, the route search guide device

including: a map information storage unit being multi-layered, the map information storage unit having an electronic map information covering more detailed road information toward lower layers; a guide route search unit for searching a route, using a map information in a lower layer in the map information storage unit, for a vicinity of one of a starting location and a destination and for searching a route, using a map information in an upper layer in the map information storage unit, for a location other than the starting location and the destination; a course change location extraction unit for specifying a traveling direction of a guide route searched by the guide route search unit and a course change location, road types being changed at the course change location; and a detour route search unit for searching a vicinity of the course change location using a map information in a lower layer and using the guide route when a newly-extracted search result is the same as the guide route and using the newly-extracted search result as a detour route when the newly-extracted search result is different from the guide route. This structure allows to provide a user with a route having the minimum distance in order to reach a destination. It is possible to use both a guide route information and a detour route information when a guidance is performed.

0008

Further, a route search guide device according to the present invention has a structure of including a route storage unit for storing an information on the detour route as data including a node information indicating an intersection of a road and a link information indicating a route. This structure makes it possible to use a stored detour route information and avoid performing a detour

route search for the same location for the subsequent times.

0009

Further, a route search guide device according to the present invention has a structure that when the course change location specified by the course change location extraction unit matches a course change location of the detour route stored in the route storage unit, the detour route is reflected on the search of the guide route. This structure allows to generate a guide route information by using a previously stored detour route information.

0010

Further, a route search guide device according to the present invention has a structure including an external storage medium for storing the information of the detour route. This structure makes it possible to store a generated detour route information in an external storage medium and use it at another terminal.

0011

Further, a route search guide device according to the present invention has a structure that, the information of the detour route read from the external storage medium can be reflected on a guide route search together with other detour route information stored in the route storage unit. Owing to this structure, it is possible to perform a route search by using a detour route information which is generated at another terminal and stored in an external medium and possible to perform a route guidance using this search result. In addition, it is possible to use another detour route information at another terminal which is

generated at an own-vehicle device and stored in an external storage medium and possible to reflect this another detour route information on a route search guide.

0012

Further, a route search guide device according to the present invention has a structure which allows the information of the detour route to be read from the external storage medium. Subsequently, a check for consistency with those of map information data included in the map information storage unit, i.e. the structure, style and form. The information of the detour route is then stored in the route storage unit. This structure allows only a detour route information, which is consistent with a map information included in a map information storage unit held by a terminal, to be stored and saved in a route storage unit.

0013

Further, a route search guide device according to the present invention has a structure including: a camera device for obtaining an information of a traffic signal; a traffic signal recognition unit for obtaining and cognizing an information of a signal of the traffic signal; and the detour route search unit for performing a detour route search using an installation location of the traffic signal as a course change location. This structure allows for a guidance of an optimal route based on a route search which has taken a situation of a traffic signal into consideration. Thus, it is possible to drive a vehicle smoothly traveling on the route.

0014

Further, a route search guide device according to the present invention has a structure of allowing the camera device or the traffic signal recognition unit to operate. The route search guide device including the detour route search unit for performing a detour route search when a traffic signal flag data indicates a traffic signal at a node which represents an intersection at a distance specified from a current location is only present in map information data of the map information storage unit. Owing to this structure, when a vehicle approaches an intersection, traffic signal data of which is included in map information data, a camera device or a traffic signal recognition unit can be operated and an operation of changing guide routes can start.

0015

Further, a route search guide device according to the present invention has a structure of including switching means for obtaining an information of a traffic signal or a road traffic information and recognizing and determining a traffic situation of a route traveled by the vehicle so as to switch a route search from a guide route search to a detour route search. Owing to this structure, it is possible to appropriately understand an information of a route traveled by a vehicle and possible to perform an optimal route guidance which covers an entire traffic situation.

0016

Further, a route search guide device according to the present invention has a structure of including: a display unit for displaying a detour route information stored in the route storage unit as a list, wherein the display unit

displays the list together with a map of the detour route. Owing to this structure, it is possible to check each of the stored detour route information on screen at once and possible to grasp all the detour route information.

0017

Further, a route search guide device according to the present invention has a structure that an unnecessary route information can be selected from the list of the detour route information output to the display unit and the necessary information can be deleted from the route storage unit. This structure makes it possible to delete rarely-used detour route information from a route storage unit.

0018

Further, a route search guide device according to the present invention has a structure for displaying the detour route together with the guide route. This structure allows a user to recognize both a guide route and a detour route and to choose an optimal route.

0019

Further, a route search guide device according to the present invention has a structure for displaying the detour route is distinctly from the guide route. This structure makes it possible to compare a guide route and a detour route easily and choose an optimal route quickly.

0020

Further, a route search guide device according to the present invention has a structure that a regulation information including road types, grades, road widths and passable hours of the detour route is output to a display

unit together with the detour route. Owing to this structure, when a guide route and a detour route are compared, it is possible to check various information pertaining to roads and possible to widen a route selection in making a decision.

0021

Further, a route search guide device according to the present invention has a structure that when the guide route and the detour route are simultaneously displayed, the detour route is displayed with a recognizable scale irrespective of a displayed scale of the guide route. Owing to this structure, there is no need for adjusting the scale of a detour route to be displayed. Thus, it is possible to reduce the time required for checking the detour route on screen.

0022

Further, a route search guide device according to the present invention has a structure that when the guide route and the detour route are simultaneously displayed, once the vehicle has reached a point by a distance set away from a divergence point to the detour route, the presence of the detour route is displayed on a screen so as to give notice. Owing to this structure, when a vehicle approaches a vicinity of a divergence point, a detour route is presented on a screen. Thus, there is no need for a user to accurately remember a location of the detour route.

0023

Further, a route search guide device according to the present invention has a structure that once the vehicle has reached the point by the distance set away from the

divergence point to the detour route, the presence of the detour route is notified by voice. Owing to this structure, there is no need for a user to look at a screen of a display unit and check a location of a detour route during driving. The user can recognize the presence of the detour route once he/she approaches a divergence point.

0024

Further, a route search guide device according to the present invention has a structure that when the guide route and the detour route are simultaneously displayed, a segment of the guide route is replaced with a corresponding segment of the detour route, and the detour route is displayed with priority. Owing to this structure, an optimal route information can be displayed. Thus, a user can make a decision without wondering which route, guide route or detour route, should be taken.

0025

Further, a route search guide device according to the present invention has a structure that when the segment of the guide route is replaced with the corresponding segment of the detour route, the detour route replacement is distinguishably displayed from the guide route. Owing to this structure, it is possible to determine which segment of a presented guide route has a detour route at a glance.

0026

Still further, a route search guide method has a structure of including the steps of: performing a route search based on an input of a current location of a vehicle or a starting location and a destination so as to compute a guide route; extracting a traveling direction and a

location, at which road types and grades are changed, from an information of the computed guide route; and adding a weight to a link cost of a generated route result within a set distance range at a course change location and performing a route search using road map information data in a lower layer so as to compute a detour route. Owing to this structure, when a guidance of a traveling route is performed after a route search, it is possible by using both a guide route information and a detour route information to provide a user with an detailed optimal traveling route having the minimum distance to reach a destination.

0027

[Embodiments of the Invention]

Hereafter, embodiments of the present invention will be explained with reference to drawings.

0028

(The First Embodiment)

Figure 1 is a block diagram showing the composition of the route search guide device as found in the first embodiment of the present invention. In Figure 1, the current location computation unit 5 is equipped with an automotive navigation sensor 51, which includes an angle speed sensor used to detect the rotation angle speed of the vehicle and a distance sensor used to detect the travel distance of the vehicle, a GPS receiver 52, which positions the current location and orientation of the vehicle through satellite navigation, and a vehicle location computation unit 53, which computes the vehicle location based on the output of the automotive navigation sensor 51 and the GPS receiver 52. The main control unit 1 possesses a function in which a

main storage unit 11 is used to store the road network data from the map information storage unit 6 retaining road network data in the form of map information data, current location data on the vehicle from the current location computation unit 5, and location data pertaining to the starting location or the destination entered by the user through the input unit 4. Additionally, the main control unit 1 also possesses a function that causes the route search unit 7 to compute guide routes based on the data read from the main storage unit 11.

0029

The route search unit 7 comprises a guide route search unit 8, a course change location extraction unit 9, and a detour route search unit 10. The guide route search unit 8 is equipped with a function that computes the route from the starting location read from the main storage unit 11, or from the vehicle location, to the destination. The course change location extraction unit 9 extracts locations at which the travel direction or the road type or grade changes based on the computed course information. Moreover, the detour route search unit 10 is capable of generating a detour route that may be a result differing from the search result generated by the guide route search unit 8 through execution of a route search using road network data in a lower layer on a point near a course change location by increasing the cost of the link of the route result generated by the guide route search unit 8. The route information computed by the route search unit 7, map data of the area including the vehicle location, vehicle location data, and the like are output to the display unit 3. Additionally, the main control unit 1 is also capable of sending data to the audio output unit 2, which in turn will

provide the user with guide information by means of voice as necessary.

0030

For the route search guide device that is configured as described above, the operation and processing steps are explained using the flow chart given as Figure 2. First, settings are made by entering data items, wherein each data item represents the starting location and destination through the input unit 4 to start a search (step S0). At this time, the current location data on the vehicle from the current location computation unit 5 may be used in place of the starting location data. The main control unit 1 causes the guide route search unit 8 inside the route search unit 7 to make a route search based on the input data and the map information data stored in the map information storage unit 6, thus generating the guide route information used in conventional route guidance (step S1). Next, the course change location extraction unit 9 runs a check on the generated guide route information to extract data on locations at which travel direction and road type or grade changes (step S2). The main control unit 1 determines whether course change location data has been prepared or not (step S3). If course change location data has been prepared, the detour route search unit 10 uses the road network data of a lower layer stored in the map information storage unit 6 to make a detour route search, prepares different route information (step S4), and ends the route search (step S5). If, on the other hand, course change location data has not been prepared, the route search will be brought to an end (step S5).

0031

As discussed above, the route search guide device of the first embodiment of the present invention is equipped with a course change location extraction unit and a detour route search unit. As such, a route search within a specific range in which a change of course may occur between starting location and destination draws on a search that uses map information data of a lower layer, enabling searches at a higher speed in less time with the added benefit of higher quality in terms of the content of the search results.

0032

In the route search guide device of the first embodiment of the present invention, a function may be brought into being in which the addition of a course change location extraction unit 9 and a detour route search unit 10 will enable detour route searches so that the search results will provide the user with not only guide routes but also detour routes for a course change location. Figure 3 gives a screen sample showing the display unit 3, indicating not only the conventional guide routes (R3, R4) but also a generated detour route (N1).

0033

Moreover, when both guide route and detour route are to be shown on the same screen, the mode of display may be modified to suit different routes, thus ensuring clear distinction between them. As shown in Figure 4, the screen display color of the generated guide routes (R5, R6) may be red, for example, while the generated detour route (N2) may be in blue or the like, with differing modes of display making way for individual display of routes on the screen. The function of displaying detour and guide routes with

such means of distinction will permit the user to recognize instantly the detour route on the displayed screen.

0034

Moreover, the main control unit 1 is equipped with a function that displays multiple windows simultaneously on the display unit 3 of the route search guide device of the first embodiment of the present invention so that, in addition to the guide route offered as the result of a conventional search, the detour route that is the result of a search in a lower layer may be displayed in a separate window at any scale on top of the other regardless of the screen size. Figure 5 is a screen sample of the display unit 3 in which a detour route that is the result of a search in a lower layer is shown on a low scale in a separate window simultaneously with the window showing the guide route on a high scale. The presence of such a function in which a detour route of a different scale is displayed on the screen together with the guide route makes it possible for immediate recognition of the generation of a detour route as well as access to its details.

0035

Moreover, if diversion occurs between guide route and detour route while the route search guide device of the first embodiment of the present invention is providing the user with the result of a route search in the form of a guide route, a program that may have been built into the main control unit 1 may display a guide on the screen of the display unit 3 by means of text or the like indicating the presence of a point of diversion to the detour route when the vehicle reaches a location whose distance from the point of diversion is one that has been set in advance.

Figure 6 shows a screen sample showing how the user is being informed by the screen on the display unit when there is a point of diversion (C1) leading to the guide routes (R6, R7) and a detour route (N3). With the function that indicates the presence of a point of diversion to a detour route in advance, it will be possible to indicate to the user explicitly the presence of such a point when it gets closer. Additionally, as shown in Figure 7, the audio output unit 2 found as part of the route search guide device of the first embodiment of the present invention may advantageously provides information by means of voice indicating the presence of a point of diversion (C2) leading to the guide routes (R9, R10) and a detour route (N4). Using voice, the user need not look at the screen to obtain information, bringing about significant benefit in terms of safety.

0036

Moreover, the route search guide device of the first embodiment of the present invention may be configured so that the user may select, through the input unit 4, a function that will automatically substitute a generated detour as part of the guide route, displaying the resulting route as if it is a single route serving as the guide route. Figure 8 is a screen sample in which guide routes (R13, N8, R14) are shown based on the initial guide routes (R11, R12) with substitution of a detour route (N8). As can be learned, the function that preferentially indicates a detour route enables automatic substitution of a detour route as a segment of the guide route, ultimately offering a single guide route to the user.

0037

Furthermore, as in the case of the previously discussed function of modifying the mode of display to indicate detour routes and guide route in different colors, for example, the above function may also be selected by the user through the input unit 4, thus enabling the automatic substitution of a generated detour route into the guide route. In such a case, the segment with a detour route may be placed into the guide route to generate a single guide route and, so that the user may be able to recognize the detour route and the guide route individually, different modes of display may be used, for example, with the screen display of the guide route being in red while that of the detour route in blue or the like in a configuration displaying individual routes on the screen. By distinguishing the substituted detour route from the guide route, the function will lead to fast identification of which segment of a single guide route is being displayed as a detour route. Figure 9 shows a display screen sample illustrating this function.

0038

(The Second Embodiment)

Figure 10 is a block diagram showing the composition of the route search guide device of the second embodiment of the present invention. In Figure 10, the composition shown is identical to that shown in Figure 1 except that the route search unit 7 of the block diagram used to illustrate the first embodiment of the present invention is equipped with a route storage unit 12. this will advantageously avoid repetitions and the following discussions will be primarily be on the features that are different from those in Figure 1.

0039

The route storage unit 12 in Figure 10 possesses a function that retains data with information pertaining to nodes representing crossings and links representing routes, corresponding to the data on course change locations generated by the course change location extraction unit 9 and the detour route information generated by the detour route search unit 10. By making use of the data on course change locations stored in the route storage unit 12, it will be easier to incorporate detour route information in route searches.

0040

Figure 11 is a flow chart illustrating the processing procedure of the operation of the route search guide device found in the second embodiment of the present invention. Hereinafter, the discussions will primarily be on the operation in which stored detour route data is incorporated in route searches, occurring as when the data on a course change location matches detour route data stored in the route storage unit 12.

0041

First, data items each representing the starting location and the destination are entered through the input unit 4 to begin a search (step S10). During this search procedure, the data on the current location of the vehicle from the current location computation unit 5 may be used in place of the data on the starting location. The main control unit 1 causes the guide route search unit 8 to execute a route search based on the input data and the map information data stored in the map information storage unit 6 to generate guide route information used in conventional route guidance

(step S11). The route change location extraction unit 9 runs checks through the generated guide route information while extracting data on locations where a change occurs in travel direction, road type, or the like (step S12). The main control unit 1 determines whether data on course change locations has been prepared or not (step S13), ending the search if no course change location data has been prepared (step S17). If course change location data has been prepared and, in addition, the prepared data on a course change location matches a point in previously prepared data (step S14), the data on the matching detour route will be read from the route storage unit 12 (step 16), ending the search upon incorporating the detour route data that has been read in the result of the route search (step S17). If, on the other hand, the data on course change locations does not match the data on detour routes stored in the route storage unit 12, the detour route search unit 10 executes a detour search (step S15), ending the search by incorporating the generated detour route data in the result of the route search (step S17).

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As explained above, according to the route search guide device of the second embodiment of the present invention, the route storage unit is equipped with a function used to store detour routes, eliminating the need for obtaining the same detour routes repeatedly, which in turn will lead to increased speed of searches; in addition, the presence of a function that incorporates stored detour routes in guide routes makes way for offering not only the guide route but also detour routes when providing instruction and guidance.

0043

Also, the route search guide device of the second embodiment of the present invention may be equipped with a function that will display a listing of detour route information stored in the additionally provided route storage unit 12 in a tabular format. Figure 12 shows a screen sample showing a listing of detour route information stored in the display unit 3. As shown in Figure 12, all detour route information stored in the route storage unit 12 is read out, and the dates/times of preparation, course change locations, distances, names of the roads traveled, and so forth are displayed on the screen. By expanding on this function, it is also possible to provide a function through which detailed information is displayed on the screen of the display unit 3 in response to the selection of an item of information pertaining to a single detour route the user is interested in from the listing of detour route information shown in Figure 12, with the displayed information being of a type often needed by the driver such as the name of the detour route, width of the road, and hours of passage concerning the detour route in question. Figure 13 shows a screen sample displaying information on a single detour route selected by the user as his/her own choice. As can be learned, the provision of a function that displays information on stored detour routes will equip the user with a means of recognizing quickly and of evaluating the need for the aforementioned detour route and, in addition, for determining in advance whether the driver should travel the suggested detour route.

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On the other hand, as opposed to the aforementioned function, there may also be a function that enables the user to select unnecessary information from the listing of

stored detour route information shown in Figure 12 for deletion of data representing such unnecessary information. Figure 14 is a screen sample of the display unit 3, informing the user that the selected detour route information will be deleted. The function to allow deletion of stored detour routes advantageously allows the user to delete from the route storage unit when he/she comes across not so useful routes, i.e. roads that the user hardly travels. Consequently, this results in better utilization of the capacity of the storage unit and an increased efficiency.

0045

(The Third Embodiment)

Figure 15 shows the composition of the route search guide device of the third embodiment of the present invention. The composition shown in Figure 15 is identical to that shown in Figure 10, which is a block diagram of the second embodiment of the present invention, except that the main control unit 1 is equipped with a main storage unit 11 and an external storage unit 13 in parallel. To avoid repetition, the discussions hereinafter will primarily be on features different from those in Figure 10.

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In Figure 15, the external storage unit 13 possesses a function that stores data representing information on nodes and links corresponding to the course change locations generated in the course change location extraction unit 9 and detour route information generated by the detour route search unit 10, or the course change locations stored in the route storage unit 12 and detour route information. The discussions of the route storage unit 12 of the route

search guide unit of the second embodiment apply too as the route search guide device of the third embodiment will also be possible to facilitate the incorporation of detour route information in route searches through use of data on course change locations stored in external storage media that may be used by fitting to the external storage 13.

0047

Figure 16 is a flow chart that shows one sample of the processing procedure of the operation of the route search guide device in the third embodiment of the present invention. The discussions hereinafter will primarily be on the operation in which the data on course change locations draws on detour routes stored in external storage media used in the external storage unit 13 for incorporation into route searches.

0048

First, data items each representing the starting location and the destination are entered through the input unit 4 to start a search (step S20). Simultaneously, the current location data on the vehicle from the current location computation unit 5 may be used in place of the data on the starting location. The main control unit 1 causes the map information storage unit 6 to execute a search based on the input data and the map information data stored in the map information storage unit 6 to generate guide route information used in conventional route guidance (step S21). Next, the course change location extraction unit 9 runs a check through the generated guide route information for extraction of data on locations where a change occurs in travel direction, road type, or the like (step S22). The main control unit 1 determines whether a course change

location has been prepared (step S23), and ends the search if course change location data has not been prepared (step S27). If a course change location has been prepared and the detour route information stored in the external storage unit 13 matches the course change location that has been prepared (step S24), the matching detour route information will be read from the external storage media (step S25), and the search is ended by incorporating it in the guide route (step S27). If a course change location has been prepared yet it does not match the detour route information stored in the external storage unit 13, a detour route search is executed (step S26) and the search is brought to an end after incorporating the data on the generated detour route in the result of the route search (step S27).

0049

It may be necessary to check the consistency with the map information data held by the route search guide device in terms of data structure and format as well as form and the like for storage in the route storage unit when reading data on detour routes from external storage media used in the external storage unit 13 of the third embodiment of the present invention. The following discussions will be on the aforementioned procedure.

0050

Figure 17 is a flow chart illustrating the series of processing procedures through which data is stored in the route storage unit 12 after execution of checks on consistency with map information data, occurring when reading data on detour routes from the external storage media used in the external storage unit 13 of the route search guide device in the third embodiment of the present

invention.

0051

As shown in Figure 17, when the processing begins to read detour information stored in the external storage unit 13 (step S30), information, i.e., detour route information consisting in nodes and links corresponding to course change locations and detour route information, is read from the external storage media (step S31); then, the road network data stored in the map information storage unit 6 is read to check for consistency (step S32). The results of the check are evaluated (step S33) and, if consistency exists, the detour route information read from the external storage media is stored in the route storage unit 12 (step S34) to end the processing (step S36). However, if consistency with map information data does not exist, the data will be interpreted as having low reliability, resulting in the cancellation of the data on the detour route information read from the external storage media (step S35) to end the processing (step S36).

0052

As discussed above, the route search guide device of the third embodiment of the present invention, through equipment of a function that enables storage of detour routes in external storage media, will make for external uses of information on detour routes stored on its own terminal by storing it outside and, by taking advantage of its function that permits incorporation of information stored in external media for its route searches, it will also enable uses of detour routes stored on other terminals by storing them on its own terminal. Moreover, the provision of a function that checks on consistency with map

information data during reading from external media will enable storage in the route storage unit only after making sure of the absence of changes to information pertaining to nodes and links of detour routes when handling maps of different versions, ensuring correct instruction and guidance.

0053

(The Fourth Embodiment)

Figure 18 is a block diagram showing the composition of the route search guide device in the fourth embodiment of the present invention. The composition in Figure 18 differs from that of the block diagram in Figure 15 used to illustrate the third embodiment of the present invention only in that a traffic signal recognition unit 14 and a camera unit 15 have been additionally provided in place of the external storage unit 13, and it is otherwise identical to that of Figure 10. To avoid repetition, the discussions that follow will primarily be on features that differ from those of Figure 15. In Figure 18, the camera unit 15 is fitted to the vehicle and is equipped with a function that captures the image of the traffic signal light installed at the crossings just before the vehicle arrives at the crossing or the like and transmits the data signal of the captured image to the traffic signal recognition unit 14. The traffic signal recognition unit 14 is assigned the role of recognizing the signal color indicated by the traffic signal light installed at a crossing or the like the vehicle is about to enter and converting the aforementioned image data signal into a signal that represents color information for input to the main control unit 1. The main control unit 1 executes route searches based on data signals that include input of the color information of the

traffic signal light and then, in a virtually identical configuration to that explained concerning the first embodiment, outputs information that relates to guide routes, or information that relates to detour routes, for provision to the user through the display unit 3 or the voice output unit 2.

0054

Next, the processing procedure of the operation is explained for the route search guide device configured as above using the flow chart shown in Figure 19. First, data items each representing the starting location and the destination are entered through the input unit 4 to execute a route search, initiating instruction and guidance using the guide route, which is the generated result (step S40). Next, the data signal of the image of the traffic signal light captured by the camera unit 15 fitted to the vehicle is transmitted to the traffic signal recognition unit 14 for collection of color information of the traffic signal light and recognition of the color information (step S41). If the recognized color information represents red for a stop or yellow for an alert (step S42), the operation for detour route guidance will automatically start in a mode used to search for detour route information (step S43). On the other hand, if the recognized color information is blue, i.e., not red or yellow, the processing will be identical to that of step S1 in Figure 2, in which guide route guidance will be in a mode used for normal guide route searches (step S44).

0055

To continue, step S41, in which processing of traffic signal recognition found in the flow chart of Figure 19 is

illustrated, will be explained in more details. Figure 20 is a flow chart used to illustrate how the camera unit 15 or the traffic signal recognition unit 14 is operated in response to the presence of a traffic signal light flag (indicating data signal representing the presence of a traffic signal light) in a node (data signal indicating a crossing) within a specific range ahead in regard to data on routes (roads) contained in the traffic network data stored in the map information storage unit 6 or the main storage unit 11 and the route storage unit 12 fitted to the route search guide device of the fourth embodiment of the present invention. In Figure 20, when the operation of the traffic signal recognition unit 14 starts (step S50), the nodes on the guide route that has been displayed as the result of a route search executed previously and being offered are traced from the current location of the vehicle in the direction of the destination in order to find out if a traffic signal light flag exists in nodes within a specific range ahead in the route (step S51). If, as the result of a check, a traffic signal light flag exists in a node (step S52), the camera unit 15 or the traffic signal recognition unit 14, which operates in association with the camera unit 15, is started (step S53). The camera unit 15 or the traffic signal recognition unit 14, which operates in association with the camera unit 15, is stopped (step S54) to end the traffic signal processing recognition processing (step S55) when the processing executed to recognize the color information of the traffic signal light installed at the crossing the vehicle is about to enter is completed. If, on the other hand, there is no traffic signal light flag, the traffic signal processing recognition processing is ended as it is (step S55). The preceding discussions explain how the route search guide

unit of the fourth embodiment of the present invention operates.

0056

As explained above, the route search guide unit of the fourth embodiment of the present invention is equipped with a function to recognize the color information of traffic signal lights installed at crossings and the like, thus enabling the terminal to recognize the state of the traffic signal light in the travel direction for guidance suited to the state of the traffic signal light. In addition, the provision of a function that checks for a traffic signal light of a node (crossing) allows intermittent processing of recognition of color information of traffic signal lights, which leads to efficient utilization of the resources of the route search guide unit.

0057

(The Fifth Embodiment of the Present Invention)

Figure 21 is a block diagram that schematically shows the composition of the route search guide unit of the fifth embodiment of the present invention. The route search guide unit of the fifth embodiment of the present invention uses the communication unit 18 to obtain, for example, information on road congestion and the like commonly referred to as traffic information for use when searching for detour routes for guidance. As can be seen in Figure 21, information of the traffic signal light is collected from the traffic signal light or from the control tower 17 or the like of the traffic signal light through the communication unit 18, which is either built into or connected to the route search unit 17, or traffic information in the form of congestion information or the

like is collected from a traffic information center 16, upon which the route search unit 17 is used to recognize the traffic condition of the current travel direction. Here, the route search unit 17 of the figure is assumed to correspond to that in Figure 1, Figure 10, Figure 15, or Figure 18 explained in reference to the first to fourth embodiments of the present invention. If it is determined that traveling ahead on the route will not bring about any problem based on the result of recognition, the guide route will be provided to the user without modification. On the other hand, if a factor that may prevent smooth travel on the route because of congestion or the like in the guide route is found, a switchover will be initiated automatically so that the route to be provided will be changed from the previously provided guide route to a detour route.

0058

As explained above, the fifth embodiment of the present invention draws on the provision of a function that recognizes traffic condition through a means of communication, allowing the recognition of not only the state of traffic signal lights but also the condition of traffic in general, such as road congestion and restriction, thus offering guide routes that are in keeping with the traffic condition in question.

0059

[Effect of the Invention]

As explained above, the present invention is equipped with a course change location extraction unit and a detour route search unit, making for route search results that are based on map information data of a lower layer for guide routes

within a specific range, i.e., an area between starting location and destination where the travel direction, road type, and the like may change. It, therefore, enables high-speed route searches and, moreover, thanks to the function of concurrently displaying both detour routes and guide route, it can offer detour routes to the user quickly, bringing about a route search guide device capable of providing outstanding benefit as found in its enhanced quality of guide routes.

[Brief Description of the Drawings]

Figure 1 is a block diagram illustrating the configuration of route search guide device in the first embodiment of the present invention.

Figure 2 is a flow chart showing the operation and processing steps of route search guide device in the first embodiment of the present invention.

Figure 3 shows a screen sample showing a result of route search on the display unit.

Figure 4 shows a screen display which shows a guide route and a detour route with different colors.

Figure 5 shows a screen display which shows a detour route created in a lower layer in another window.

Figure 6 shows a screen sample showing how the user is being informed of a point of diversion between a guide route and a detour route.

Figure 7 shows a screen sample indicating the presence of a

point of diversion between a guide route and a detour route to a user by means of voice.

Figure 8 shows a screen sample showing a guide route with substitution of a detour route.

Figure 9 shows a screen sample which shows each guide route with substitution of a detour route with different colors.

Figure 10 is a block diagram illustrating the configuration of route search guide device in the second embodiment of the present invention.

Figure 11 is a flow chart showing the operation and processing steps of route search guide device in the second embodiment of the present invention.

Figure 12 shows a screen sample showing a listing of detour route information stored in the display unit.

Figure 13 shows a screen sample showing a detour selected from a list of detour route information.

Figure 14 shows a screen sample showing informing the user that the selected detour route information will be deleted.

Figure 15 is a block diagram illustrating the configuration of route search guide device in the third embodiment of the present invention.

Figure 16 is a flow chart showing the operation and processing steps of route search guide device in the third embodiment of the present invention.

Figure 17 is a flow chart illustrating the series of processing procedures through which data is stored in the route search guide device after execution of checks on consistency with map information data in the third embodiment of the present invention.

Figure 18 is a block diagram illustrating the configuration of route search guide device in the fourth embodiment of the present invention.

Figure 19 is a flow chart showing the operation and processing steps of route search guide device in the fourth embodiment of the present invention.

Figure 20 is a flow chart used to illustrate how the camera unit or the traffic signal recognition unit is operated in a route search guide device in the fourth embodiment of the present application.

Figure 21 is a block diagram illustrating the configuration of route search guide device in the fifth embodiment of the present invention.

Figure 22 shows a screen sample showing the result of a search by way of output indicating guide routes.

[Description of the Reference Numerals]

1. main control unit
2. audio output unit
3. display unit
4. input unit
5. current location computation unit

6. map information storage unit
7. route search unit
8. a guide route search unit
9. a course change location extraction unit
10. a detour route search unit
11. main storage unit
12. route storage unit
13. external storage unit
14. traffic signal recognition unit
15. camera device
16. traffic information center
17. traffic signal light or from the control tower
18. communication unit
19. route search guidance device
51. automotive navigation sensor
52. GPS receiver
53. vehicle location computation unit

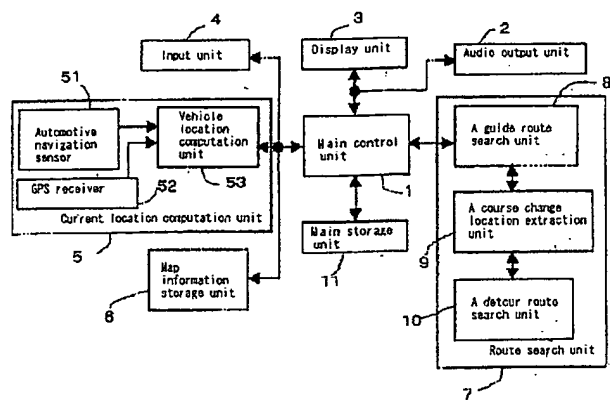


FIG001.GIF

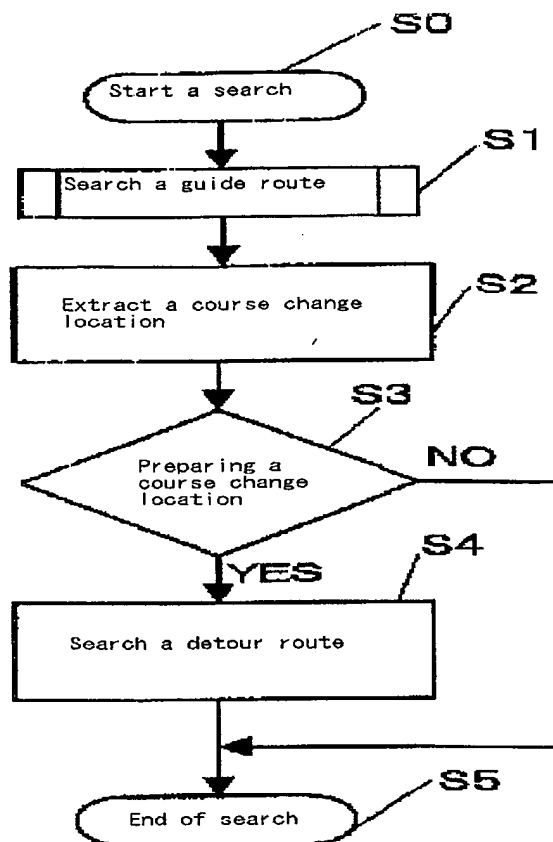


FIG002.GIF

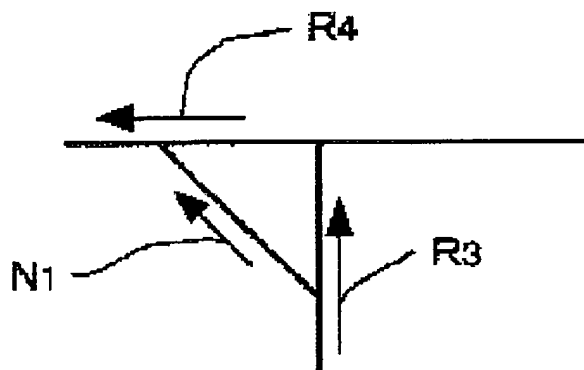


FIG003.GIF

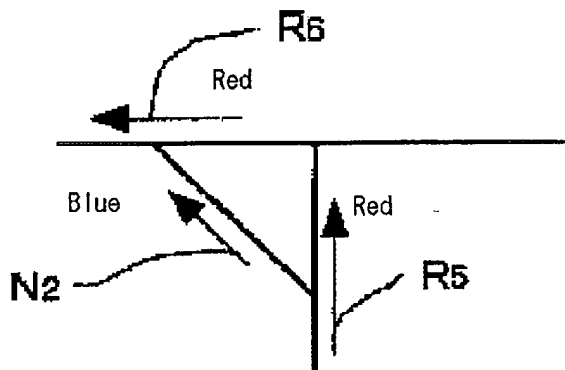


FIG004.GIF



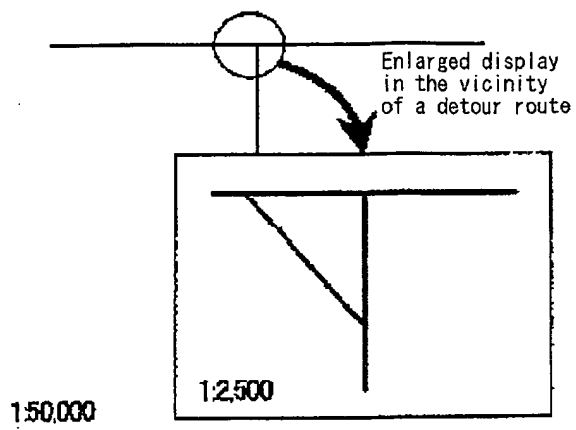


FIG005.GIF

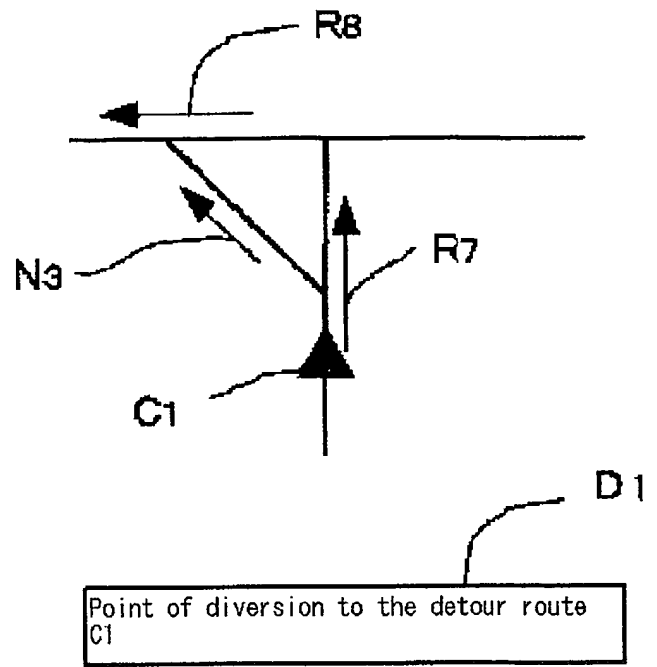


FIG006.GIF

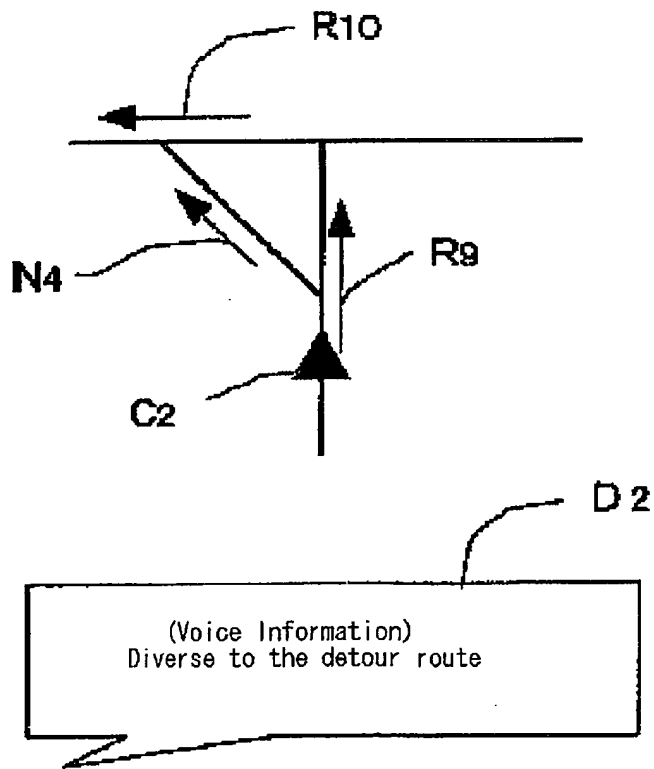


FIG007.GIF

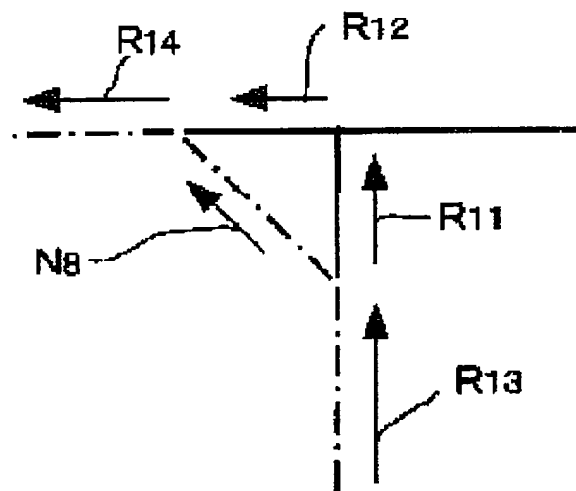


FIG008.GIF

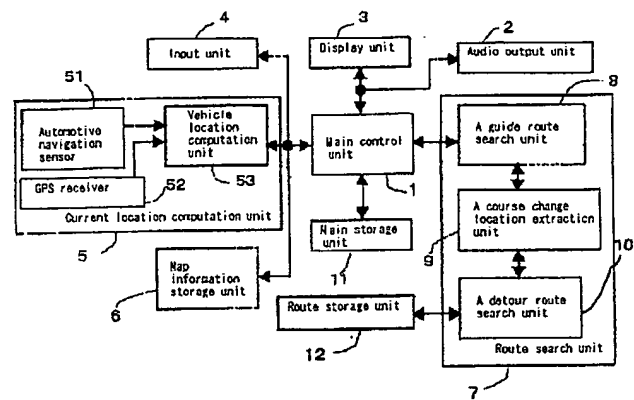
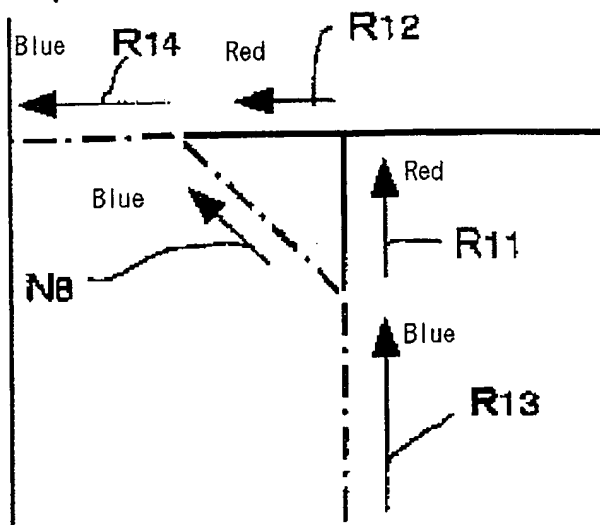


FIG009.GIF

FIG010.GIF

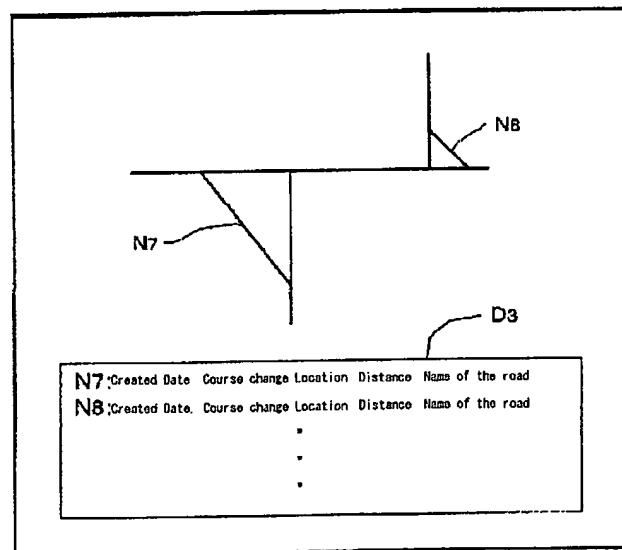
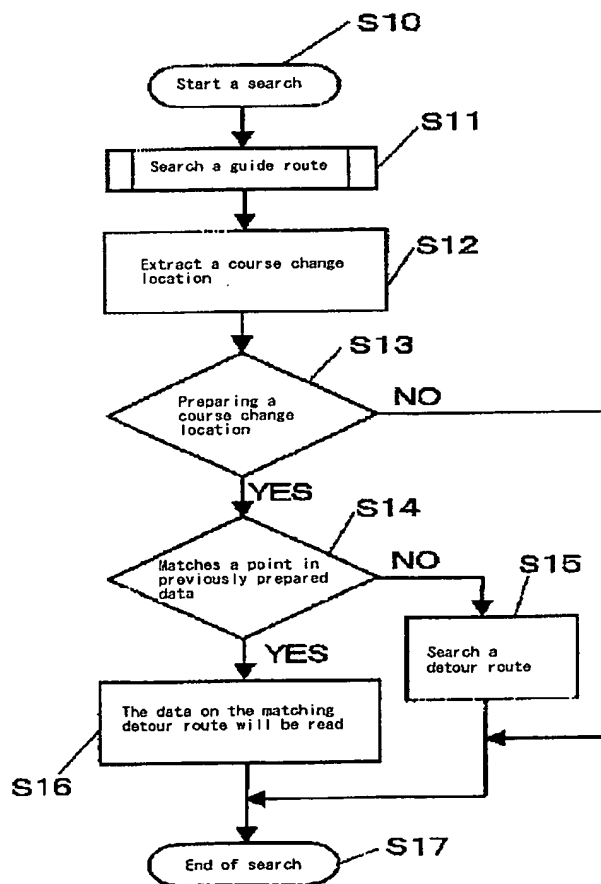


FIG011.GIF

FIG012.GIF

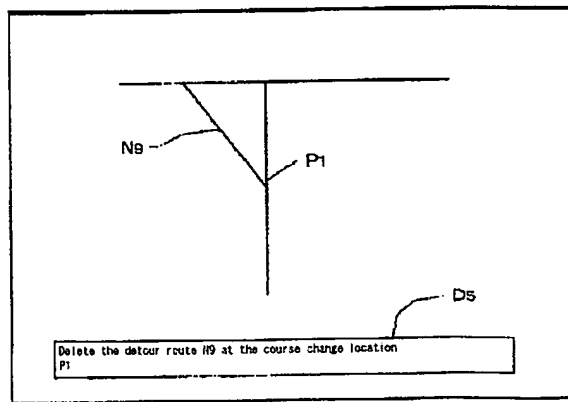
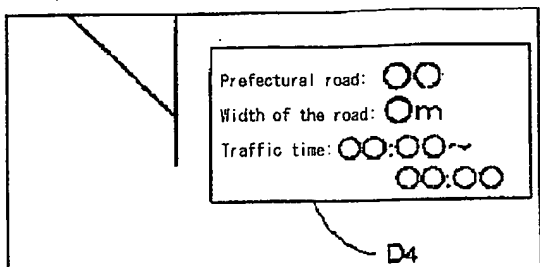


FIG013.GIF

FIG014.GIF

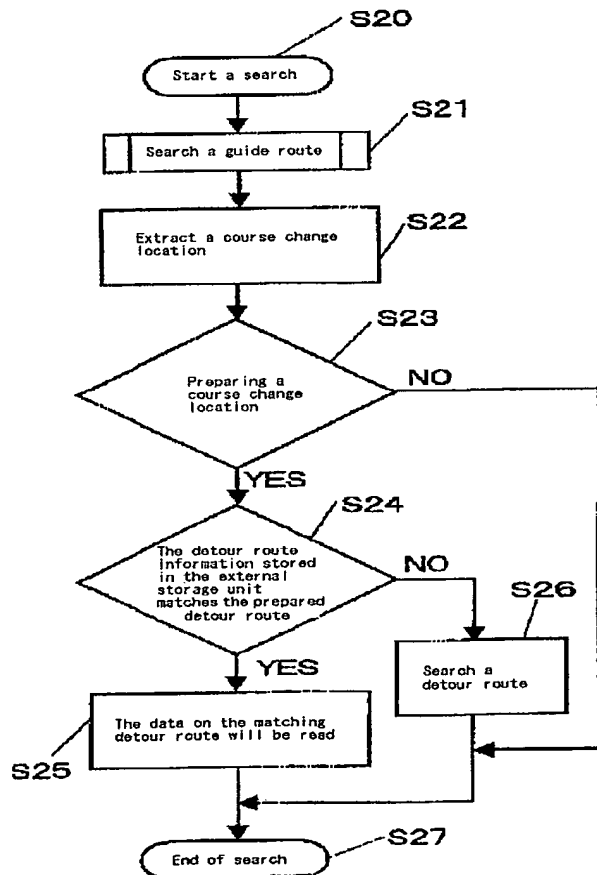
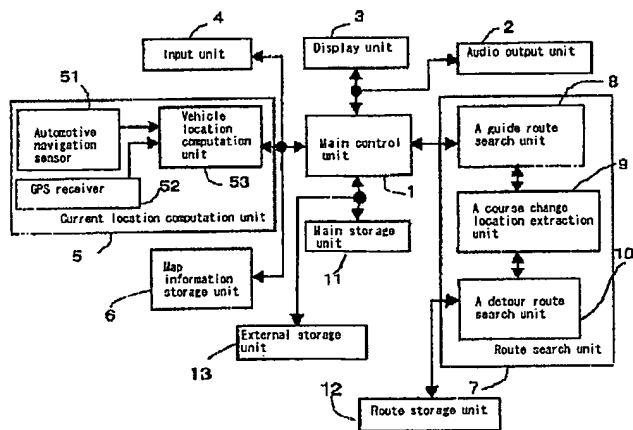


FIG015.GIF

FIG016.GIF

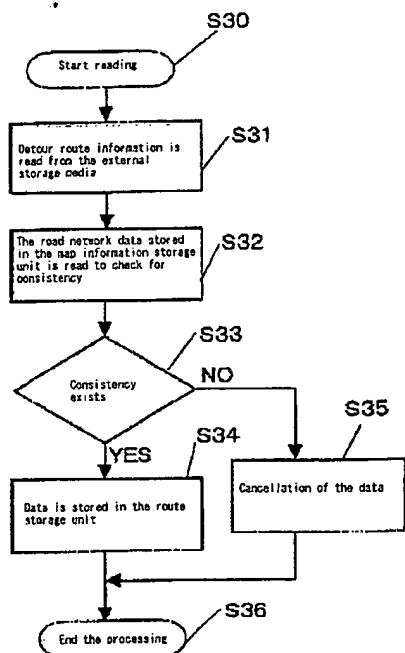


FIG017.GIF

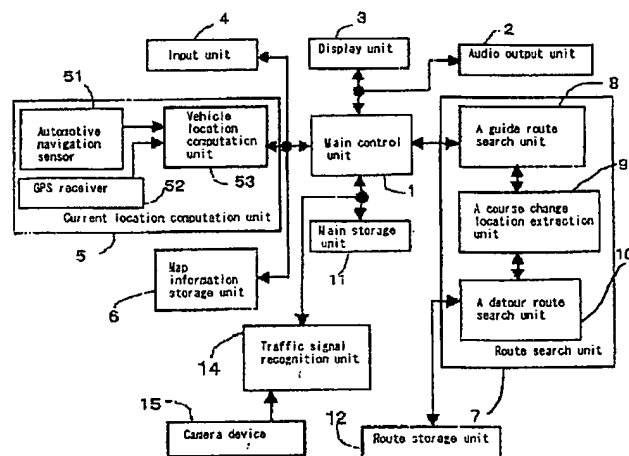


FIG018.GIF

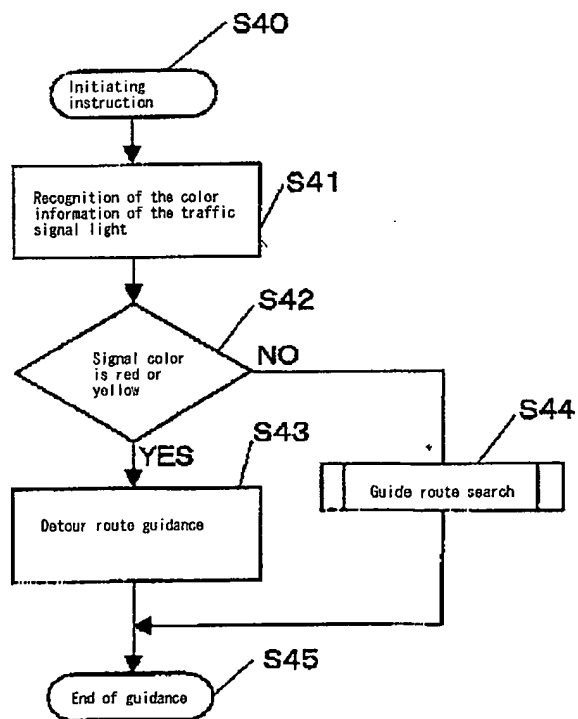


FIG019.GIF

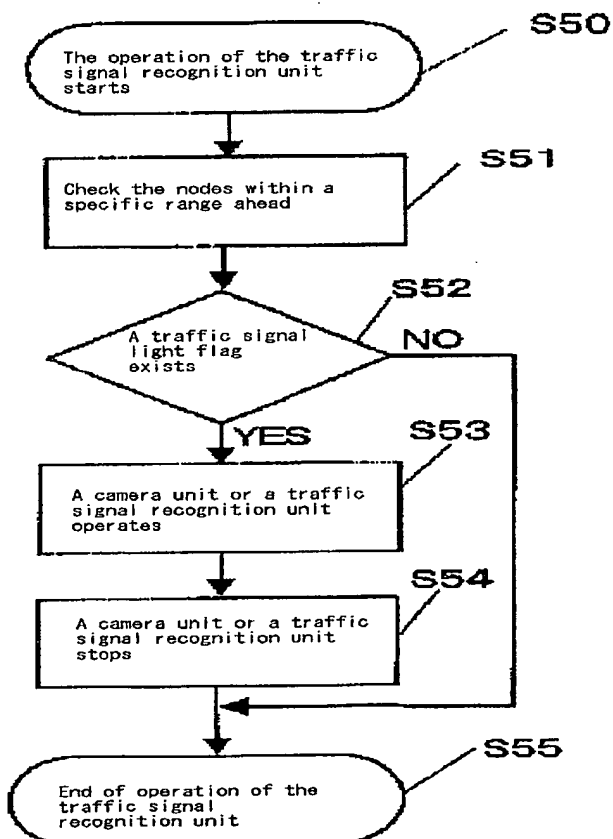


FIG020.GIF

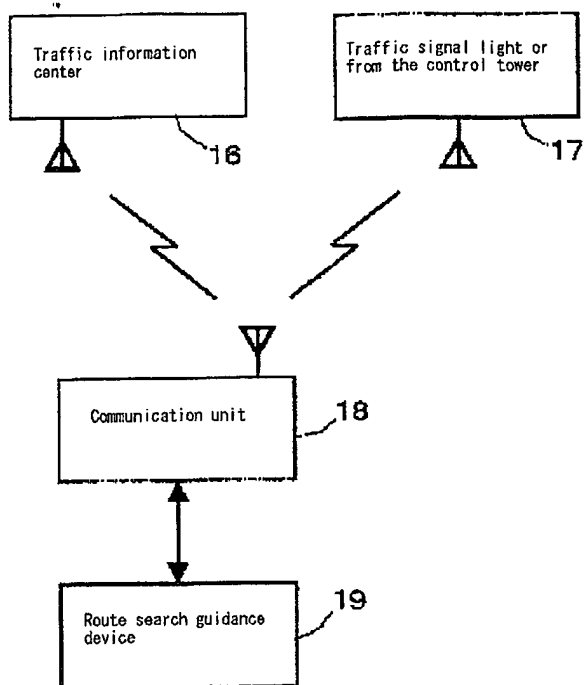


FIG021.GIF

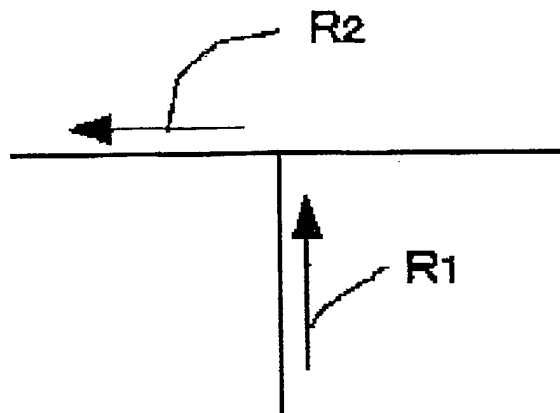


FIG022.GIF

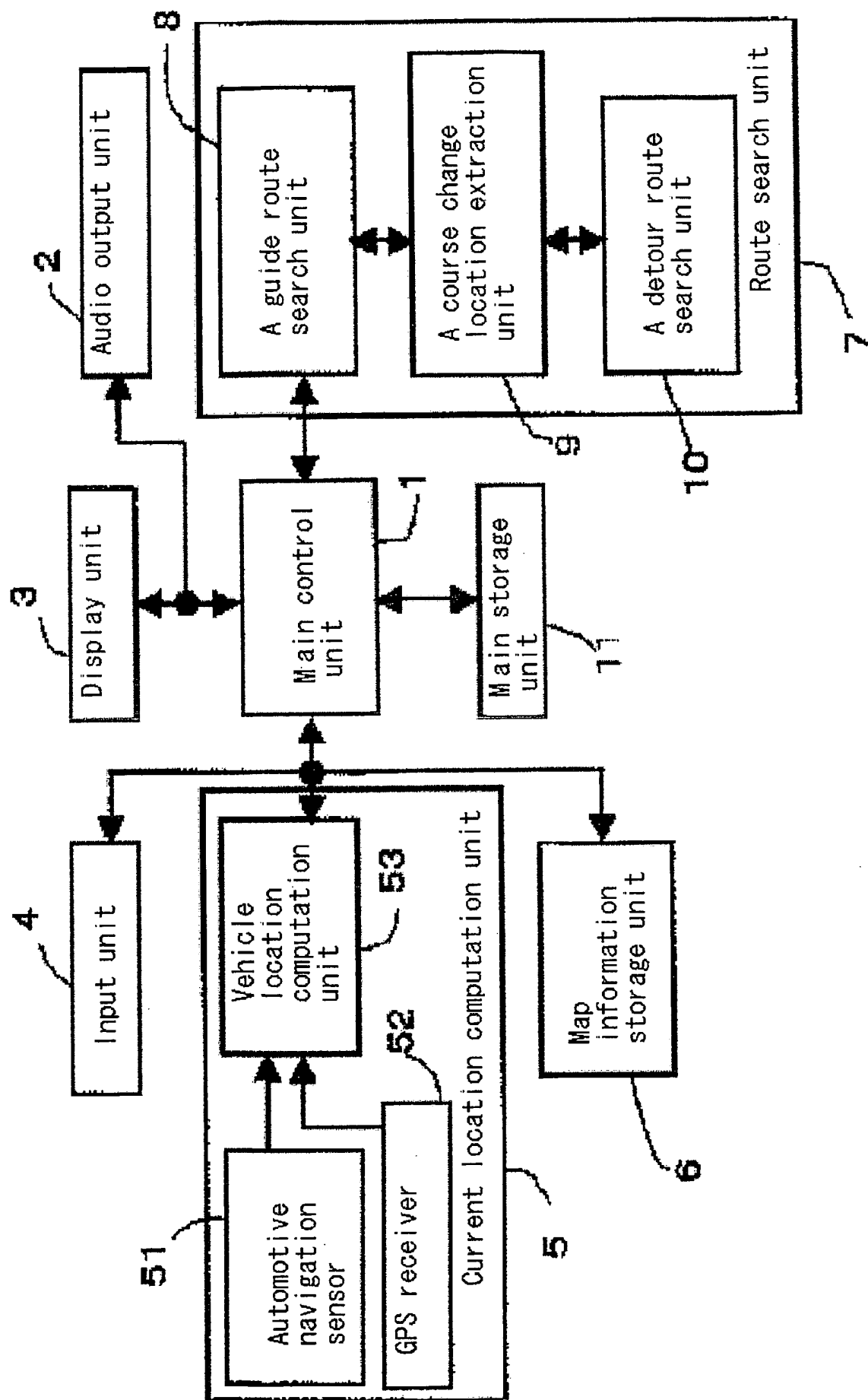


FIG001.GIF

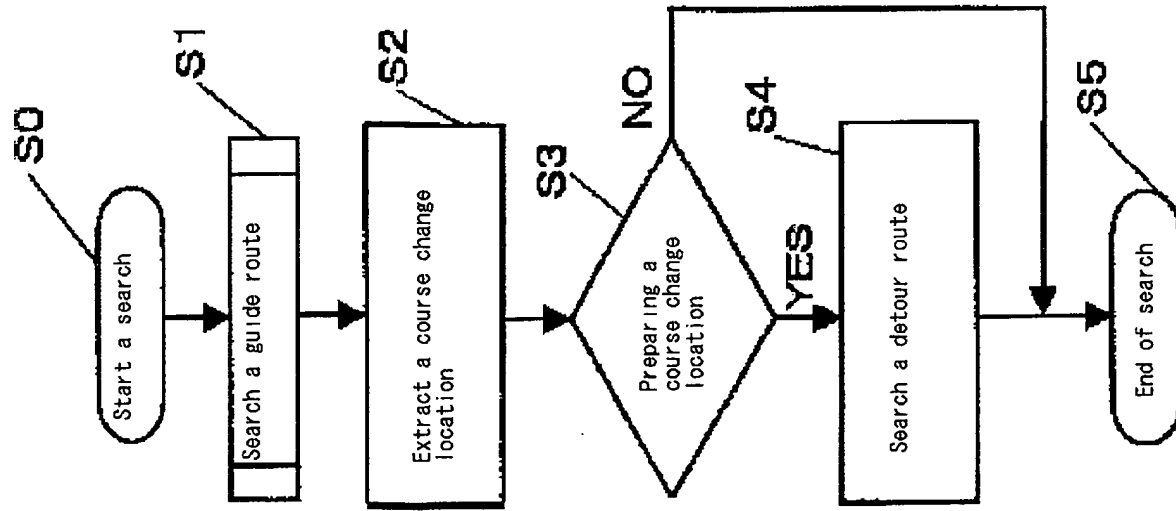


FIG0002.GIF

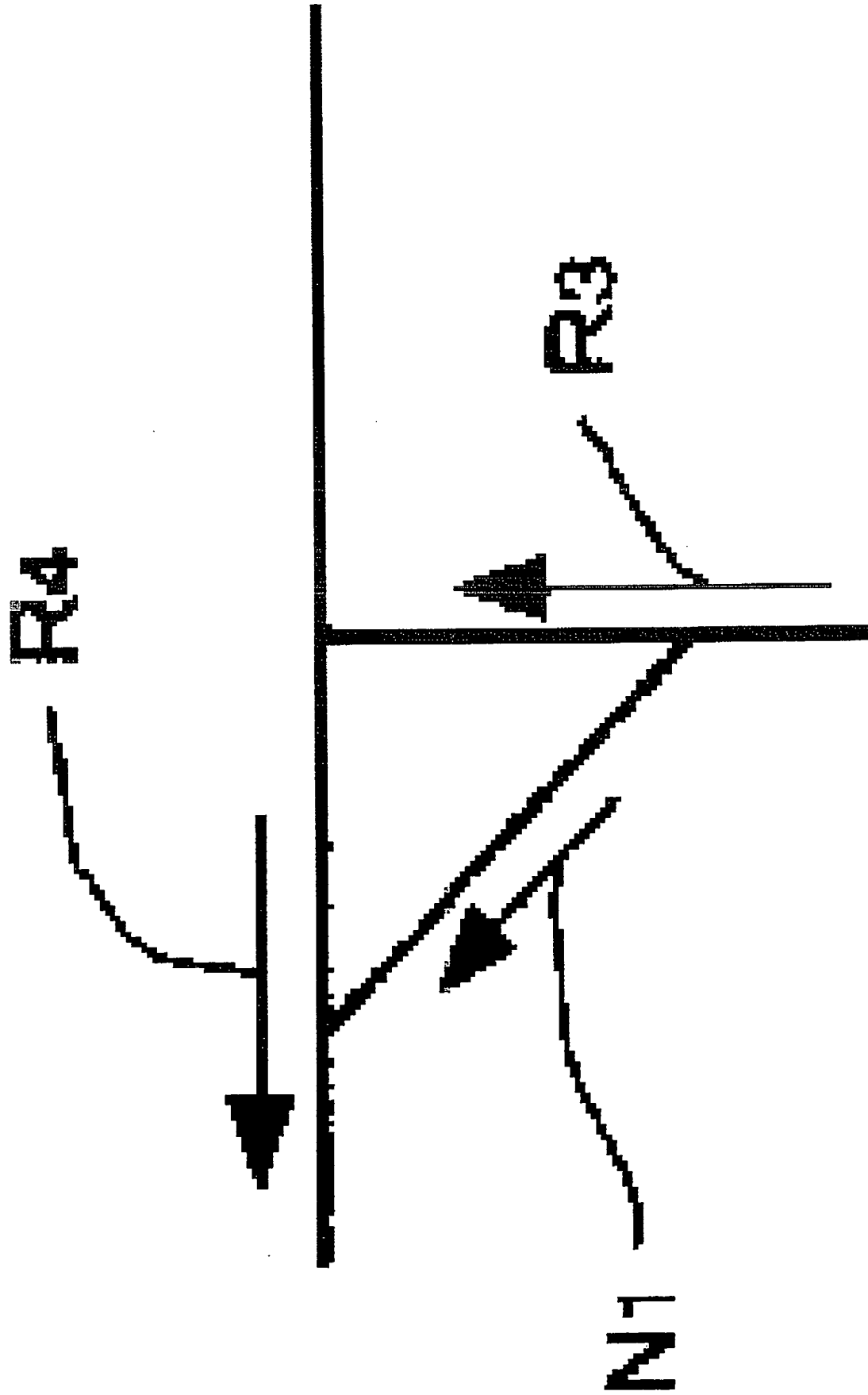


FIG0003.GIF

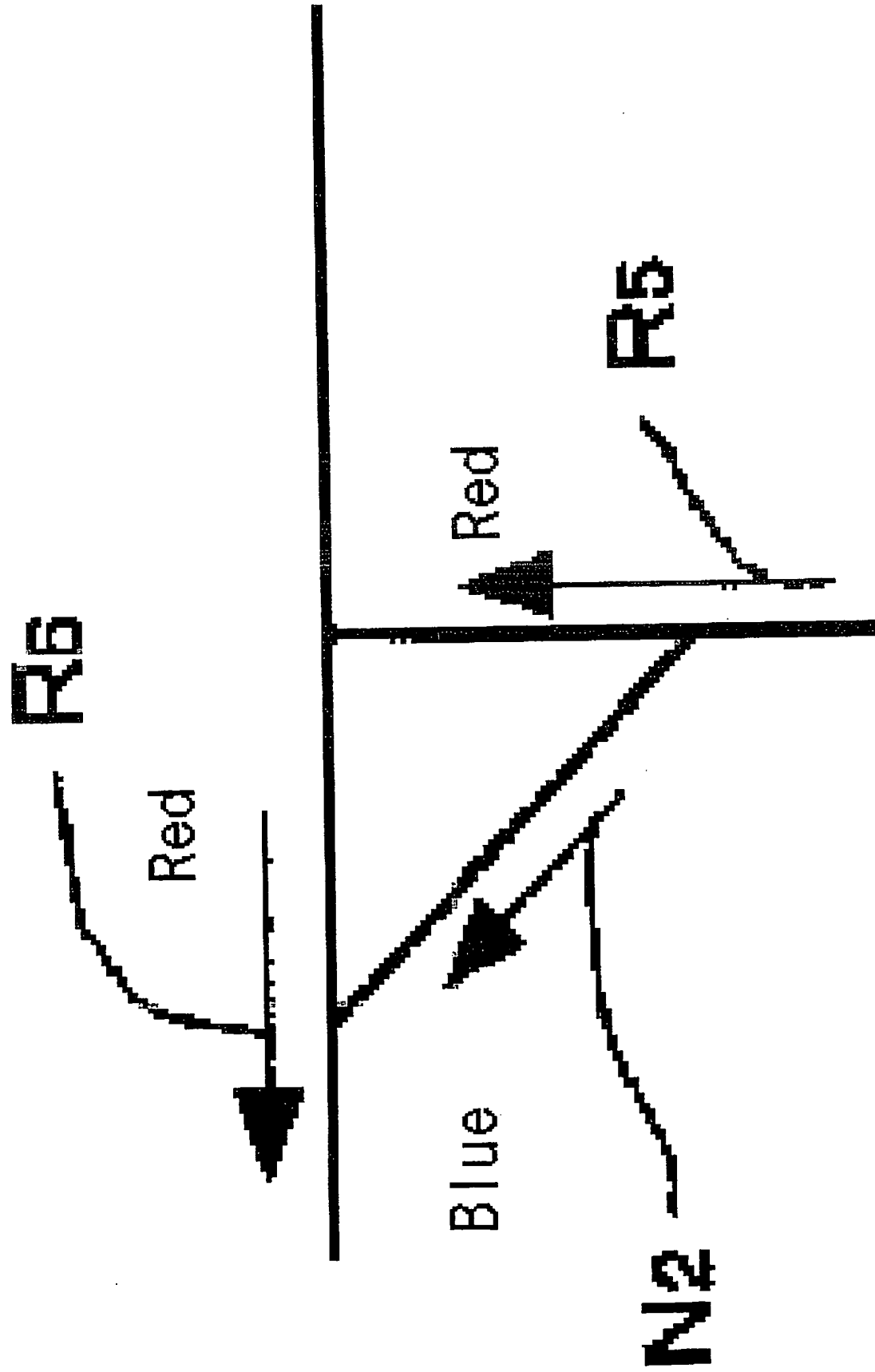


FIG0004.GIF

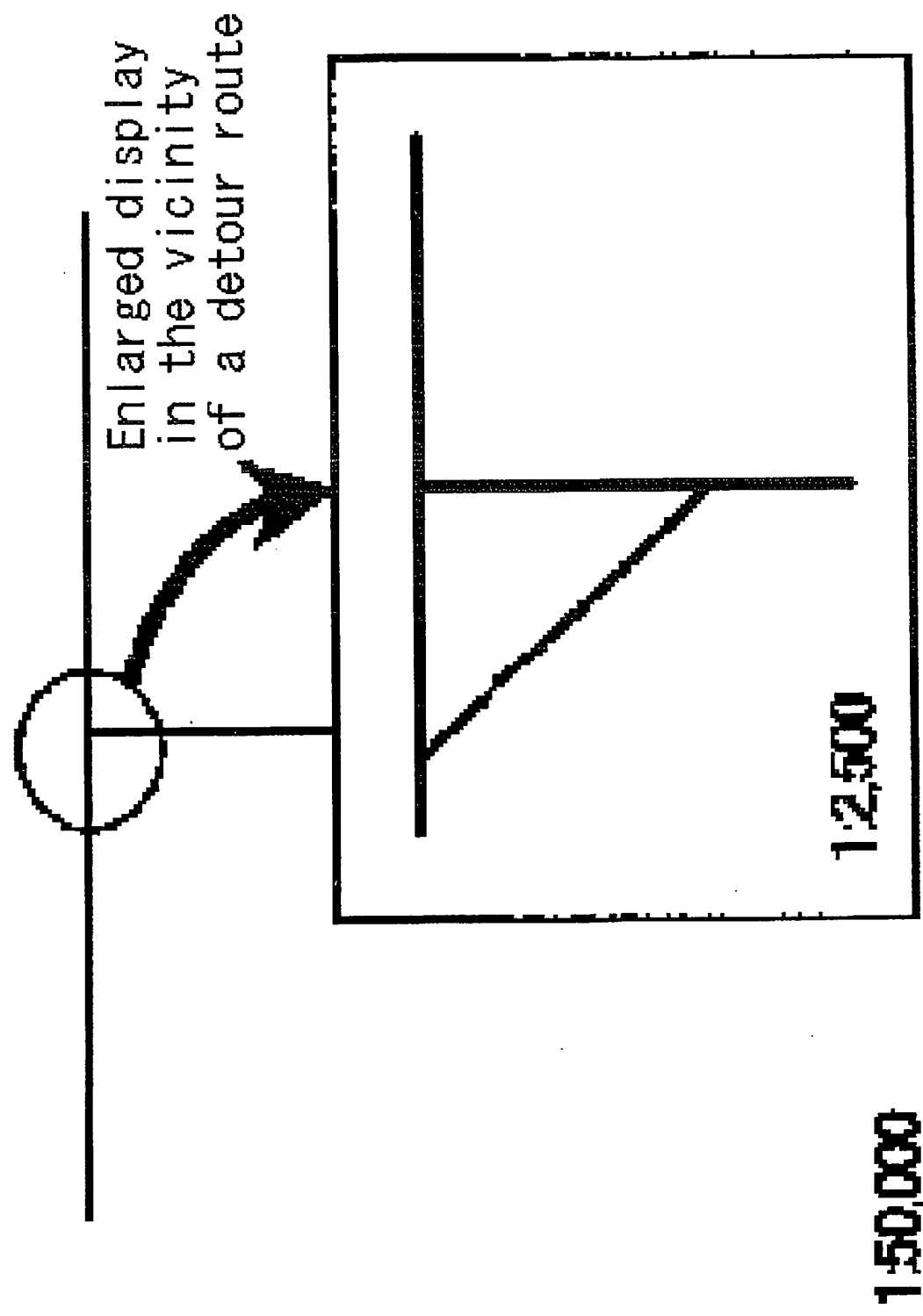


FIG005.GIF

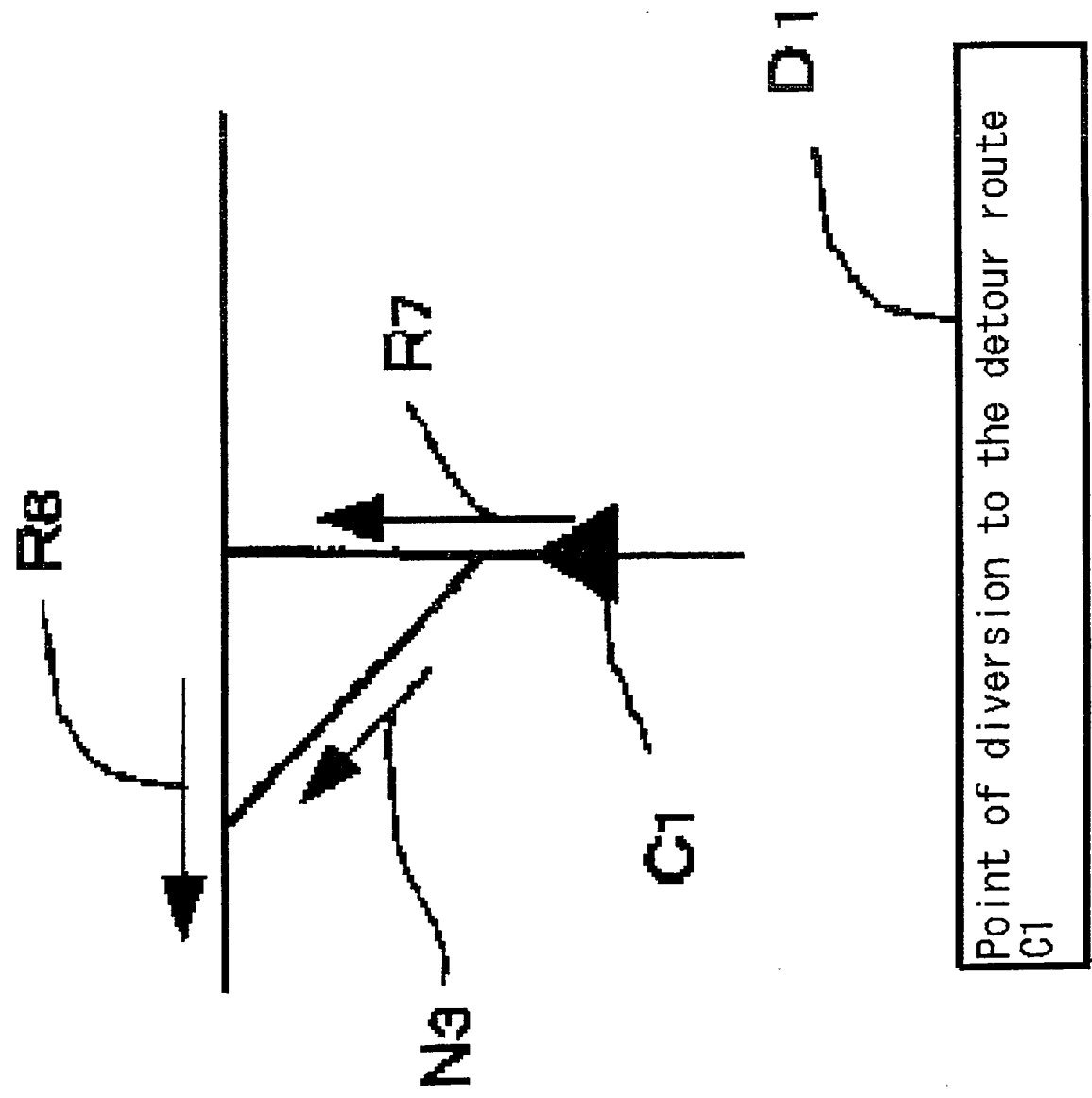


FIG0006.GIF

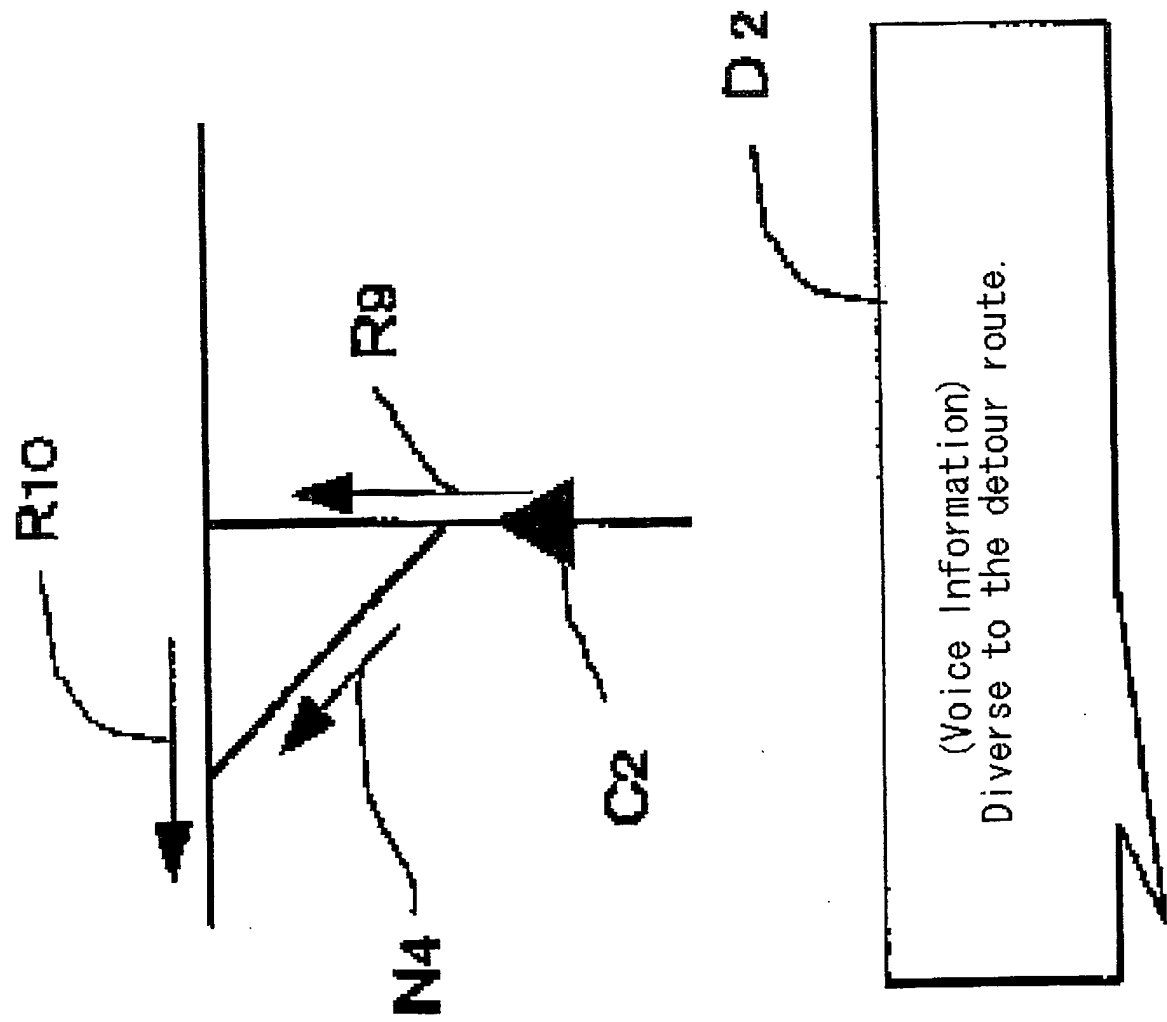


FIG0007.GIF

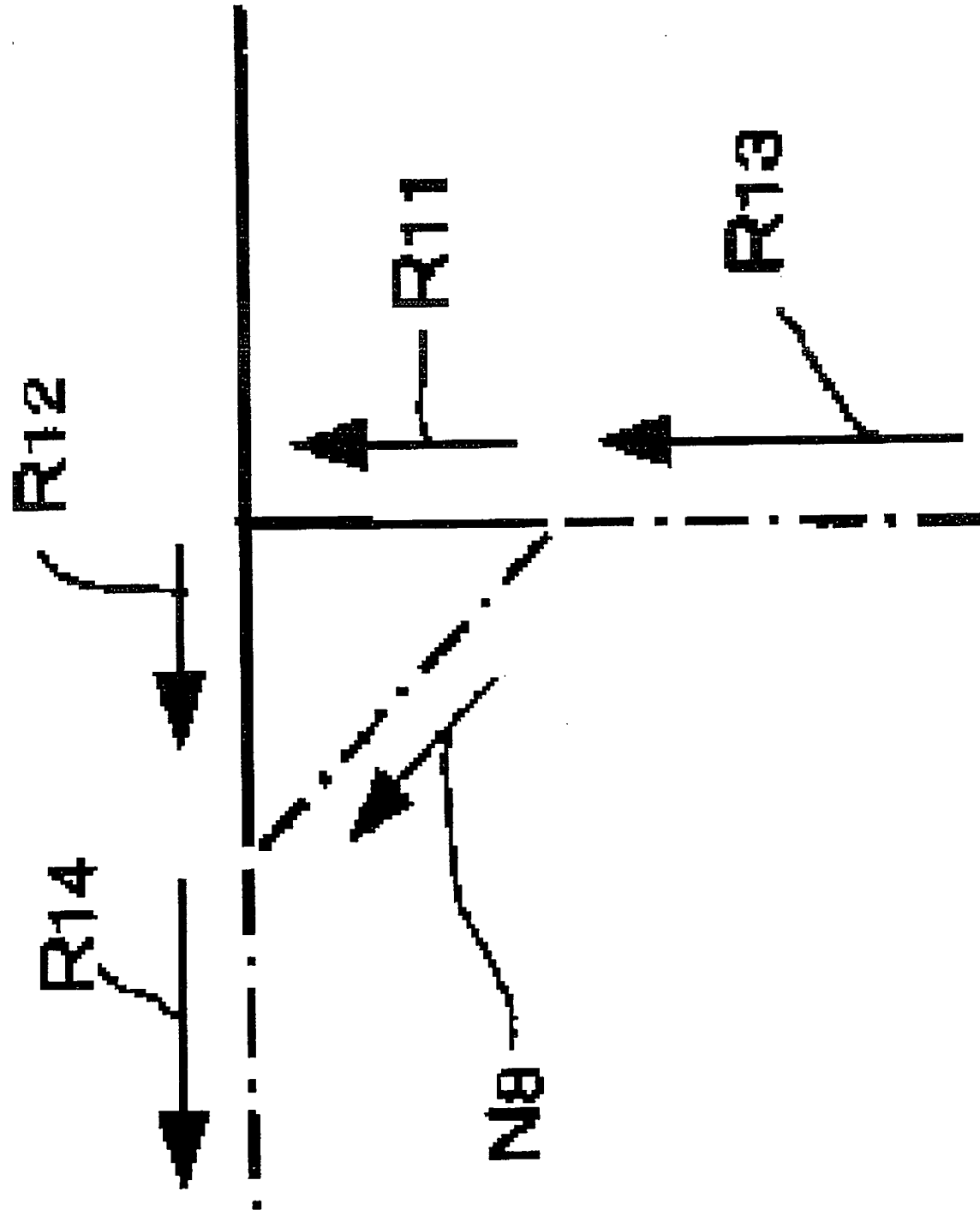


FIG008.GIF

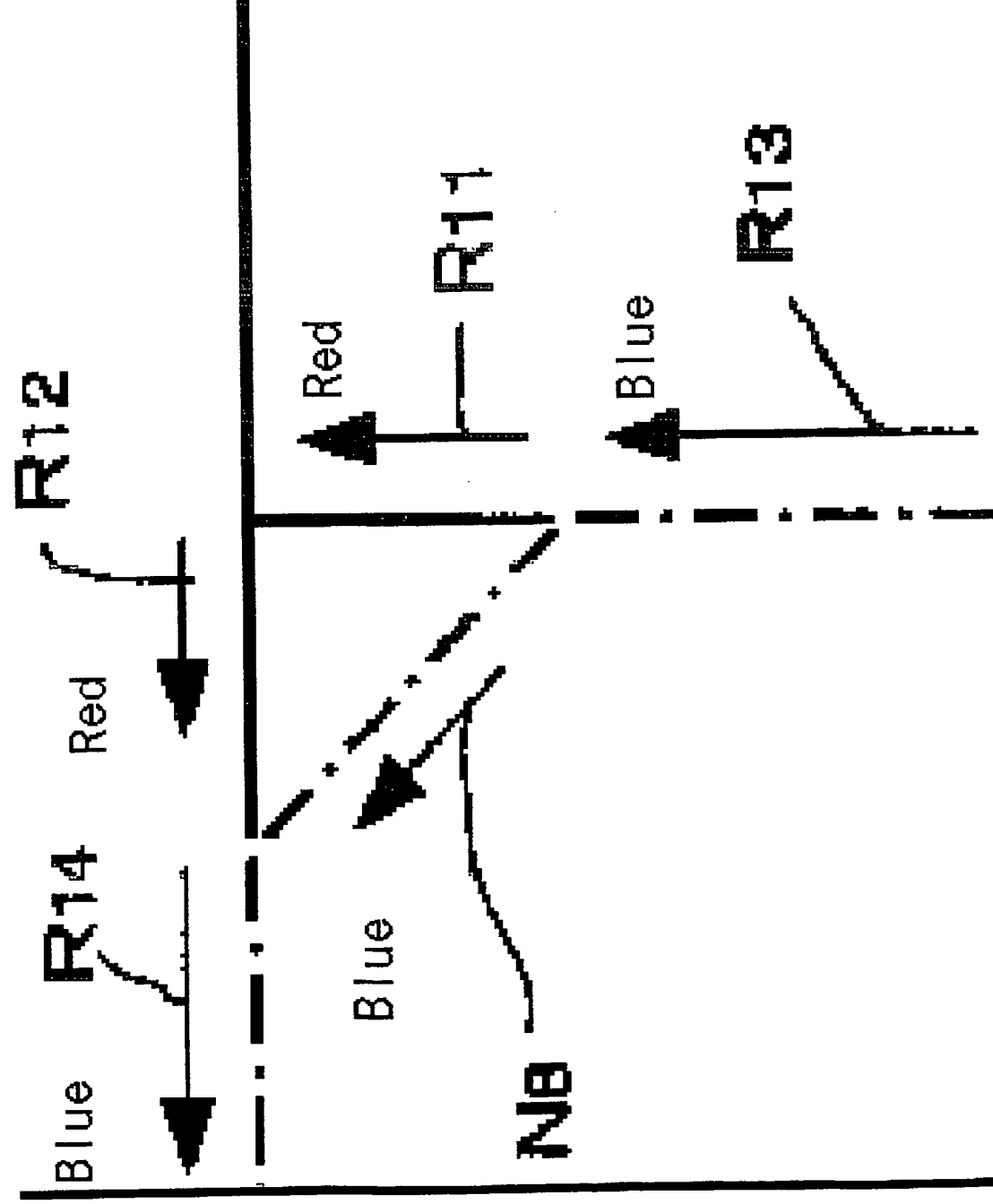


FIG0009.GIF

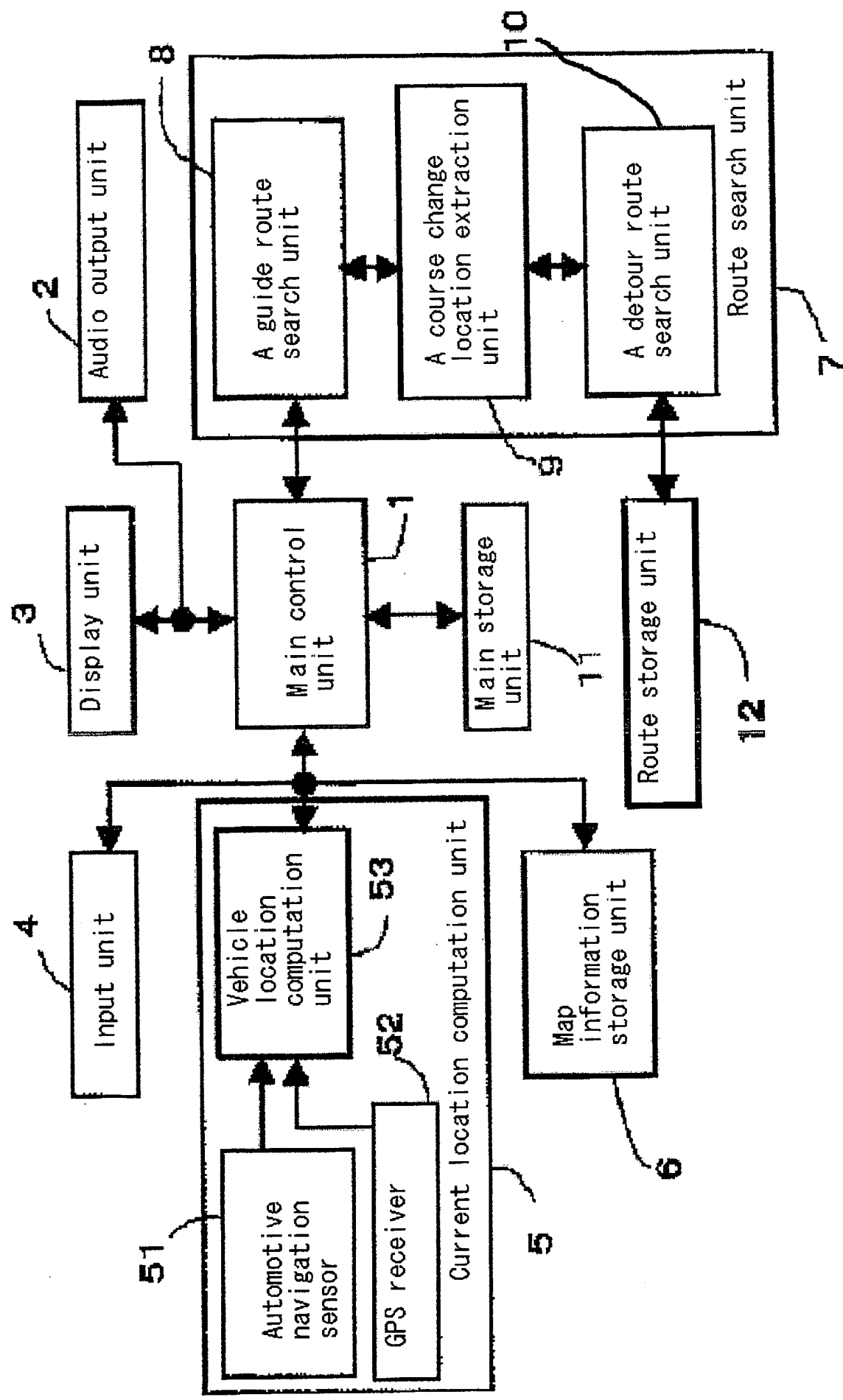


FIG010.GIF

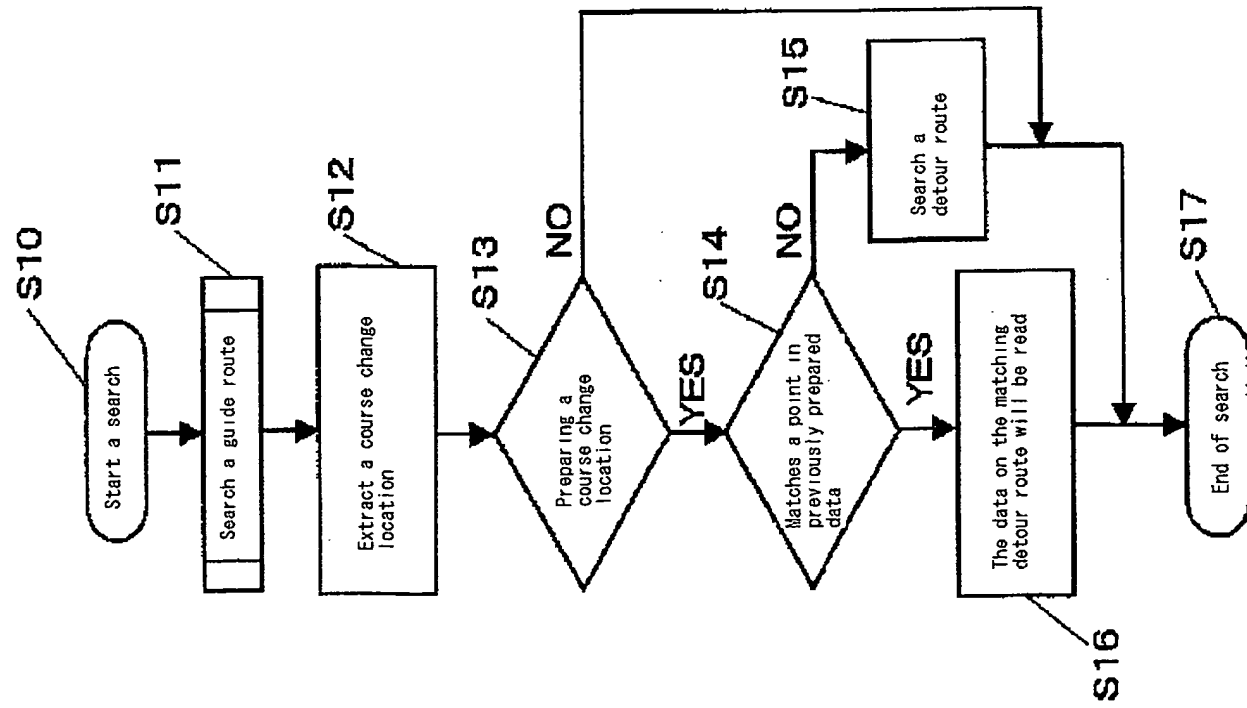


FIG011.GIF

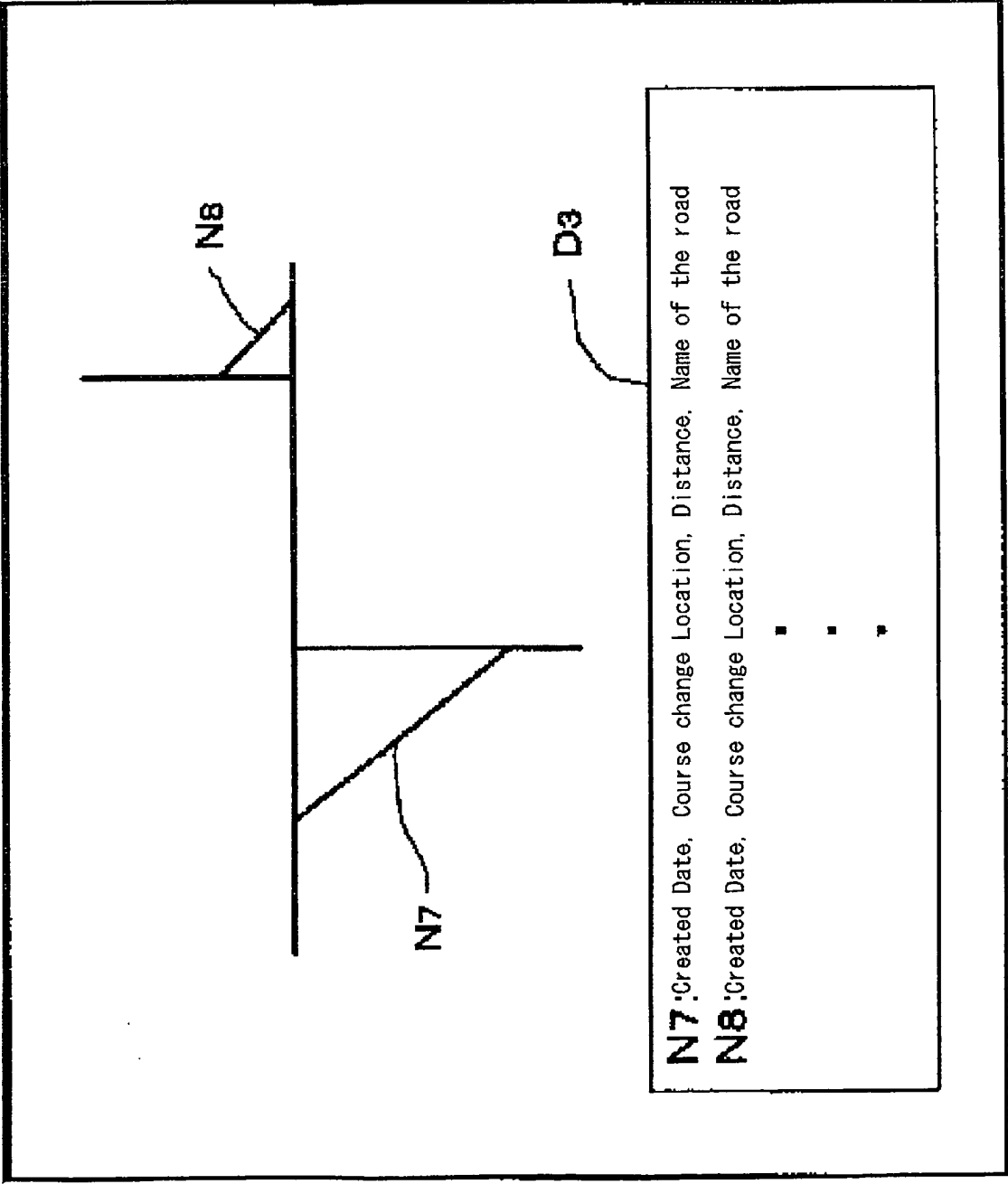


FIG012.GIF

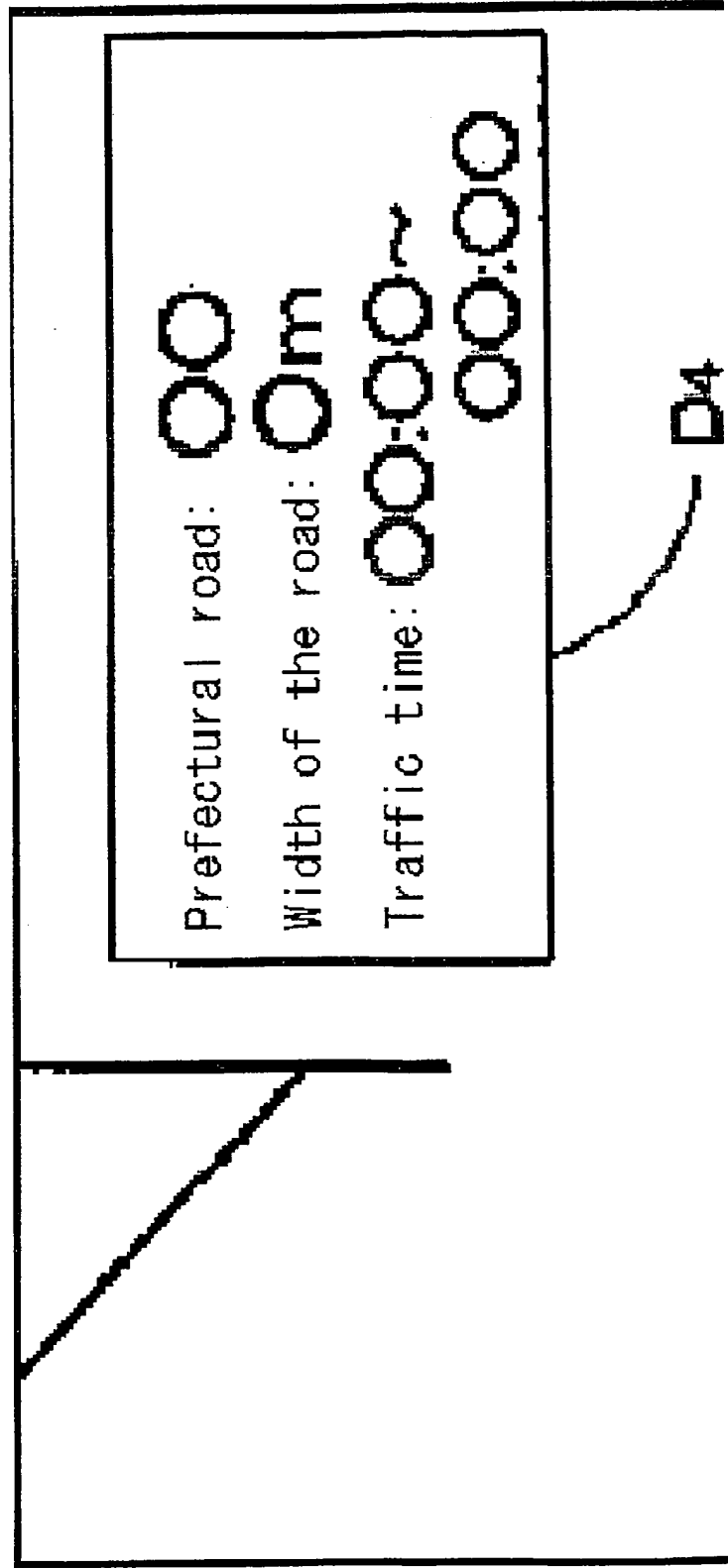


FIG013.GIF

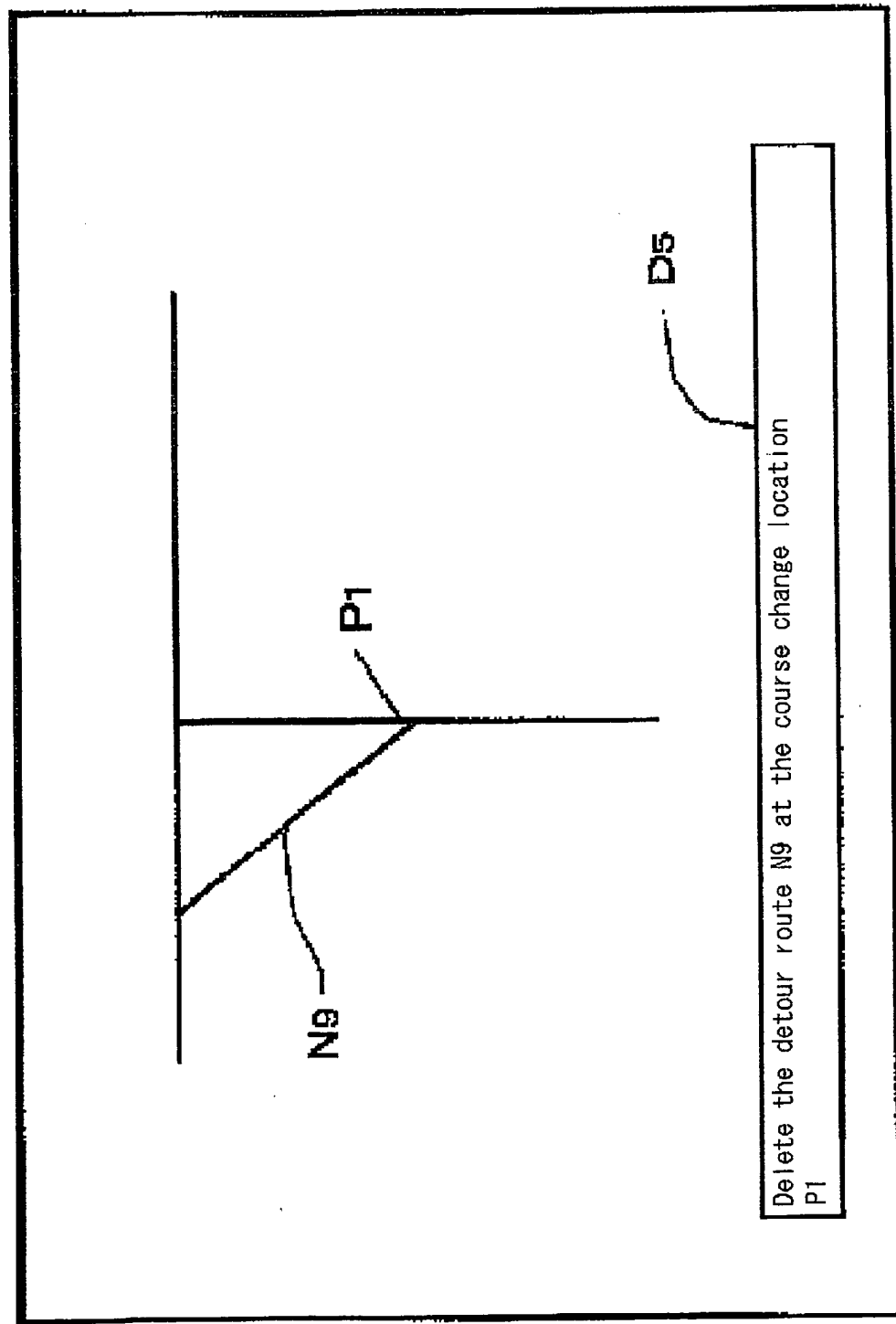


FIG014.GIF

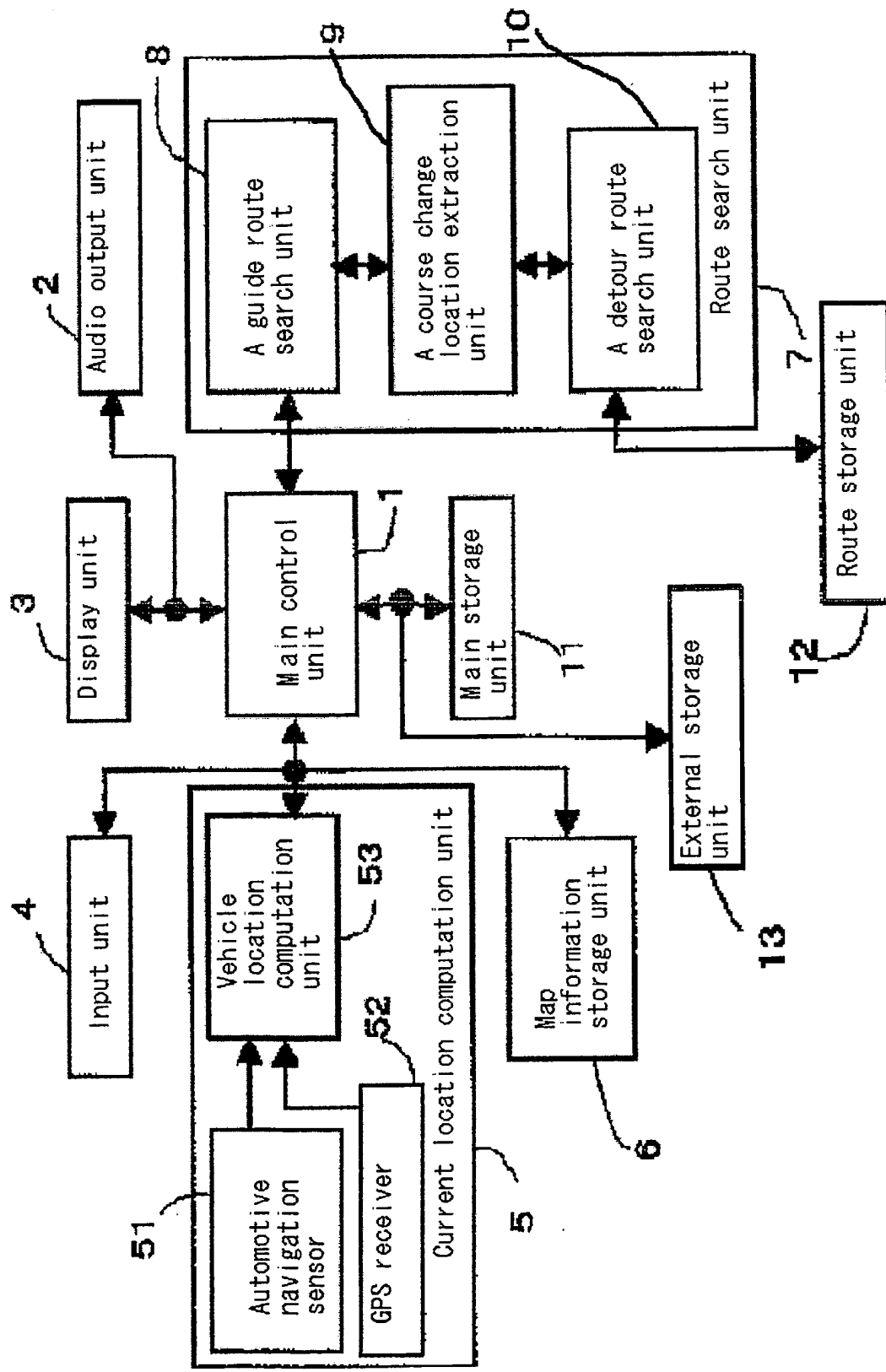


FIG015.GIF

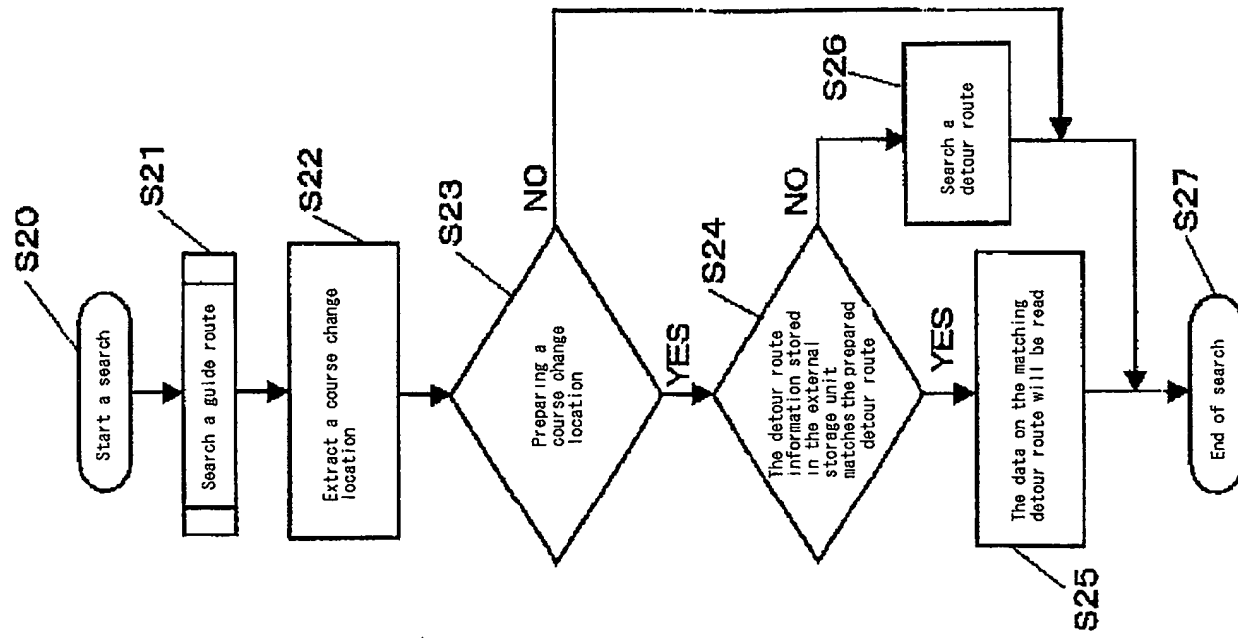


FIG016.GIF

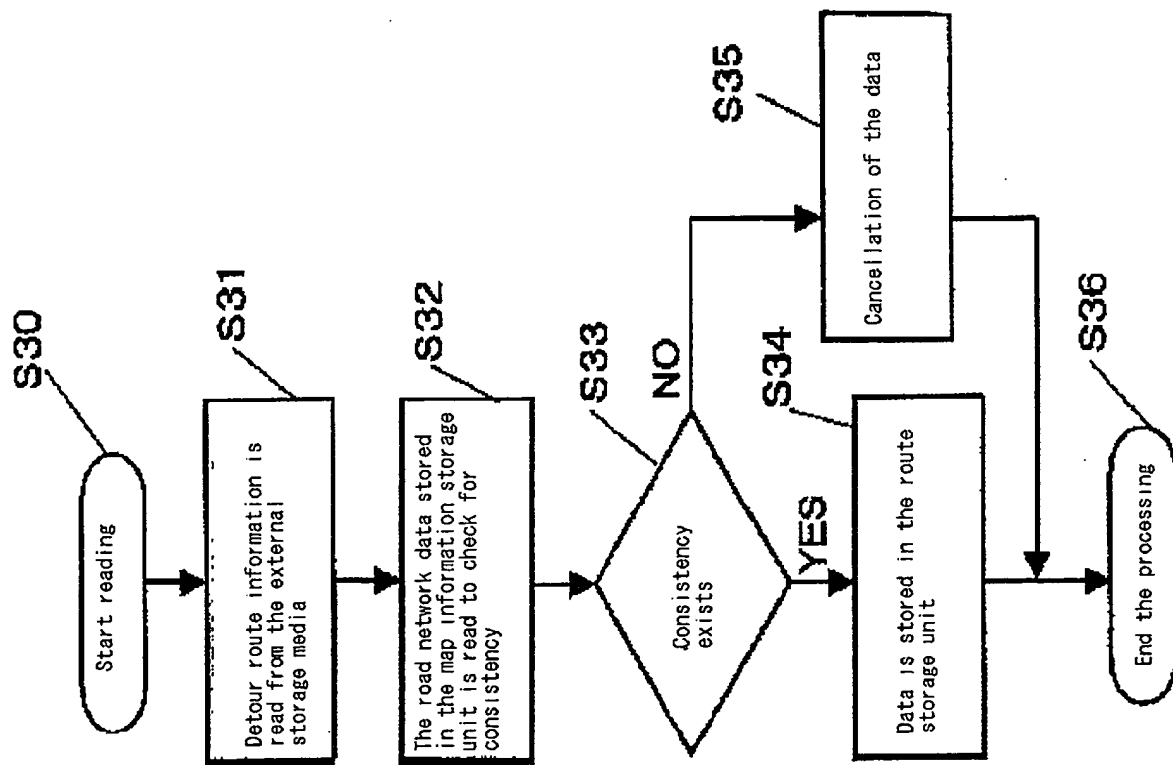


FIG017.GIF

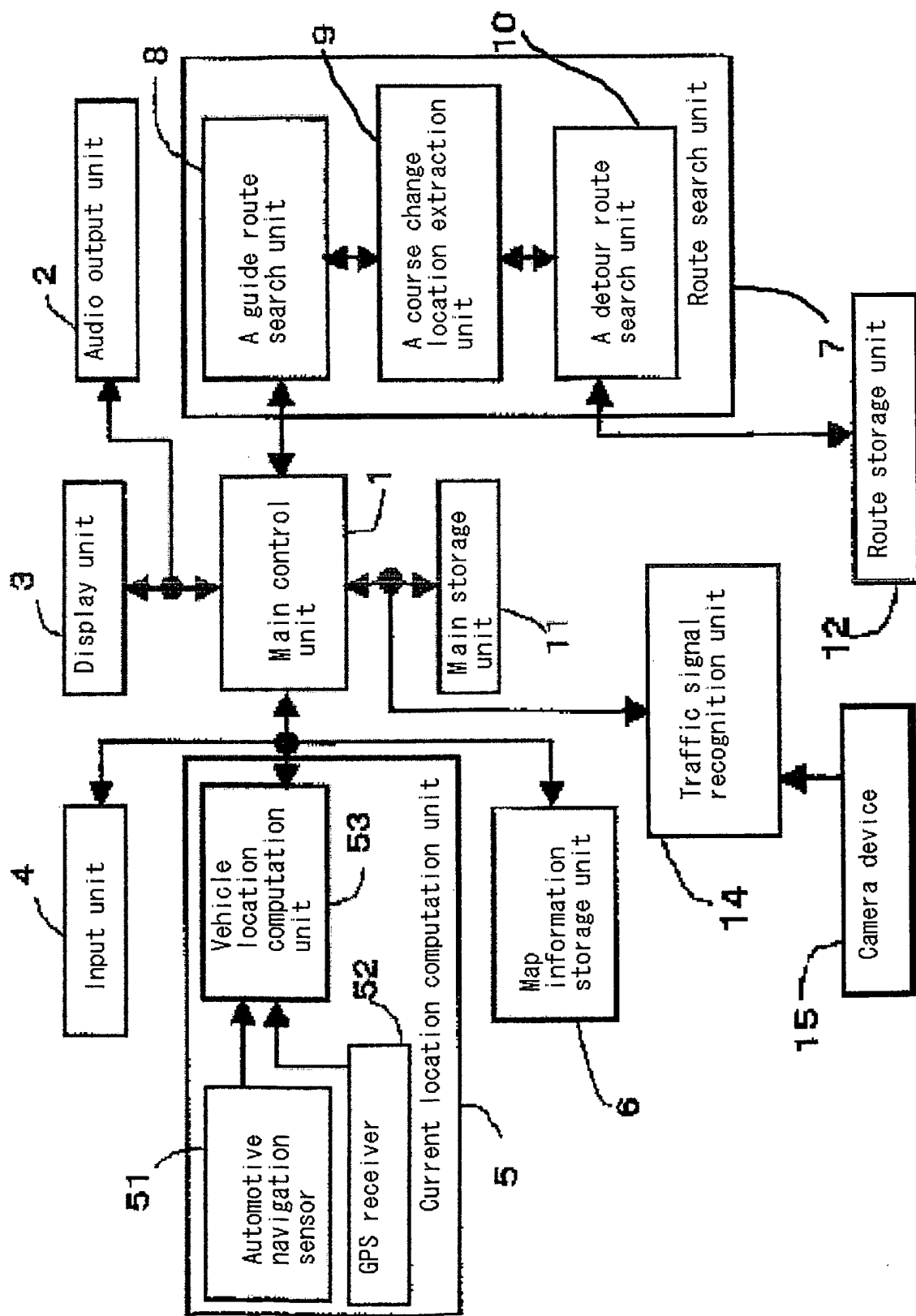


FIG018.GIF

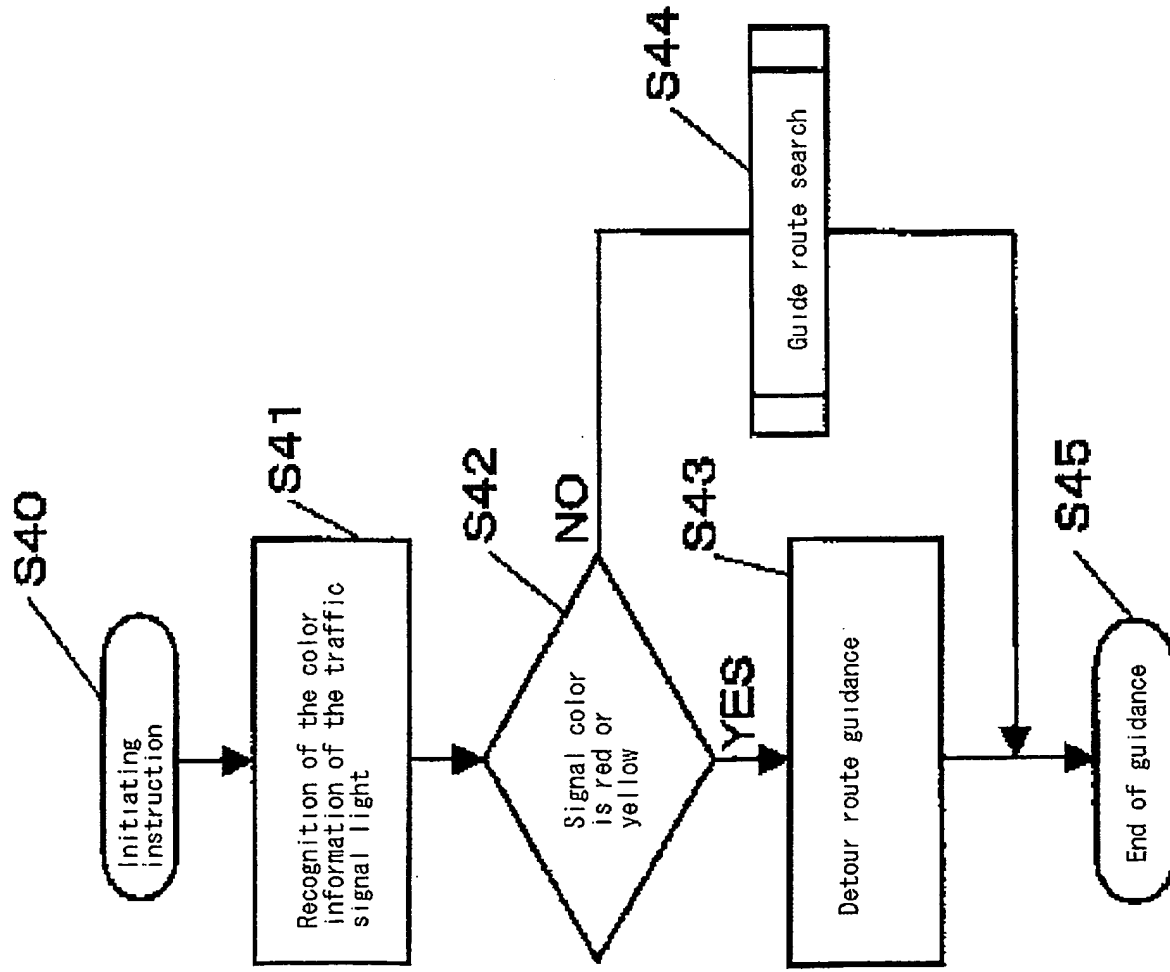


FIG019.GIF

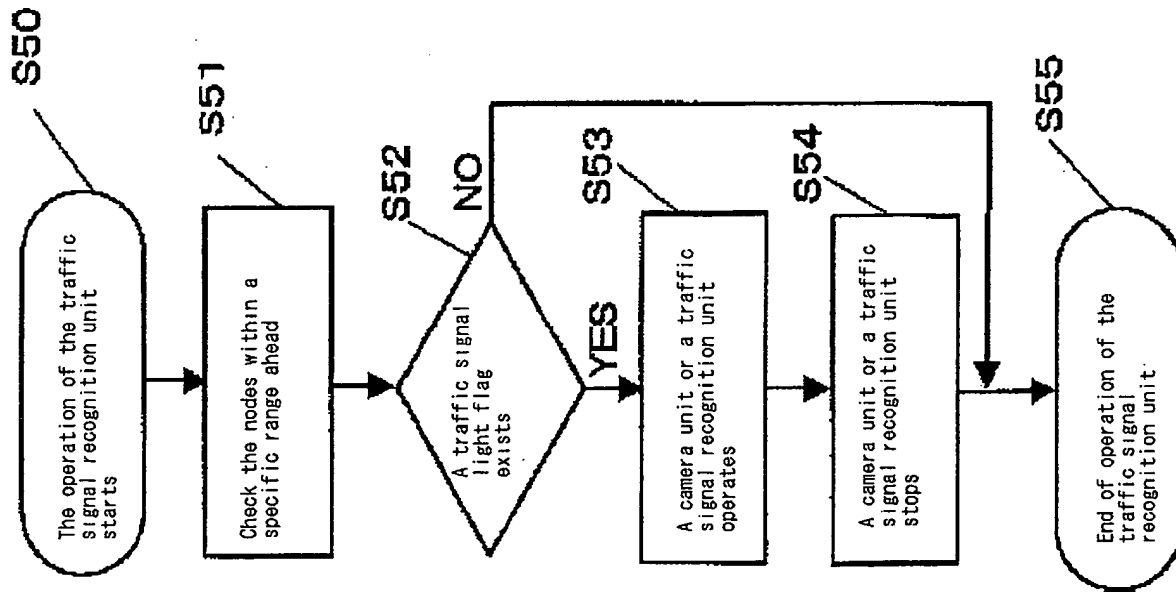


FIG020.GIF

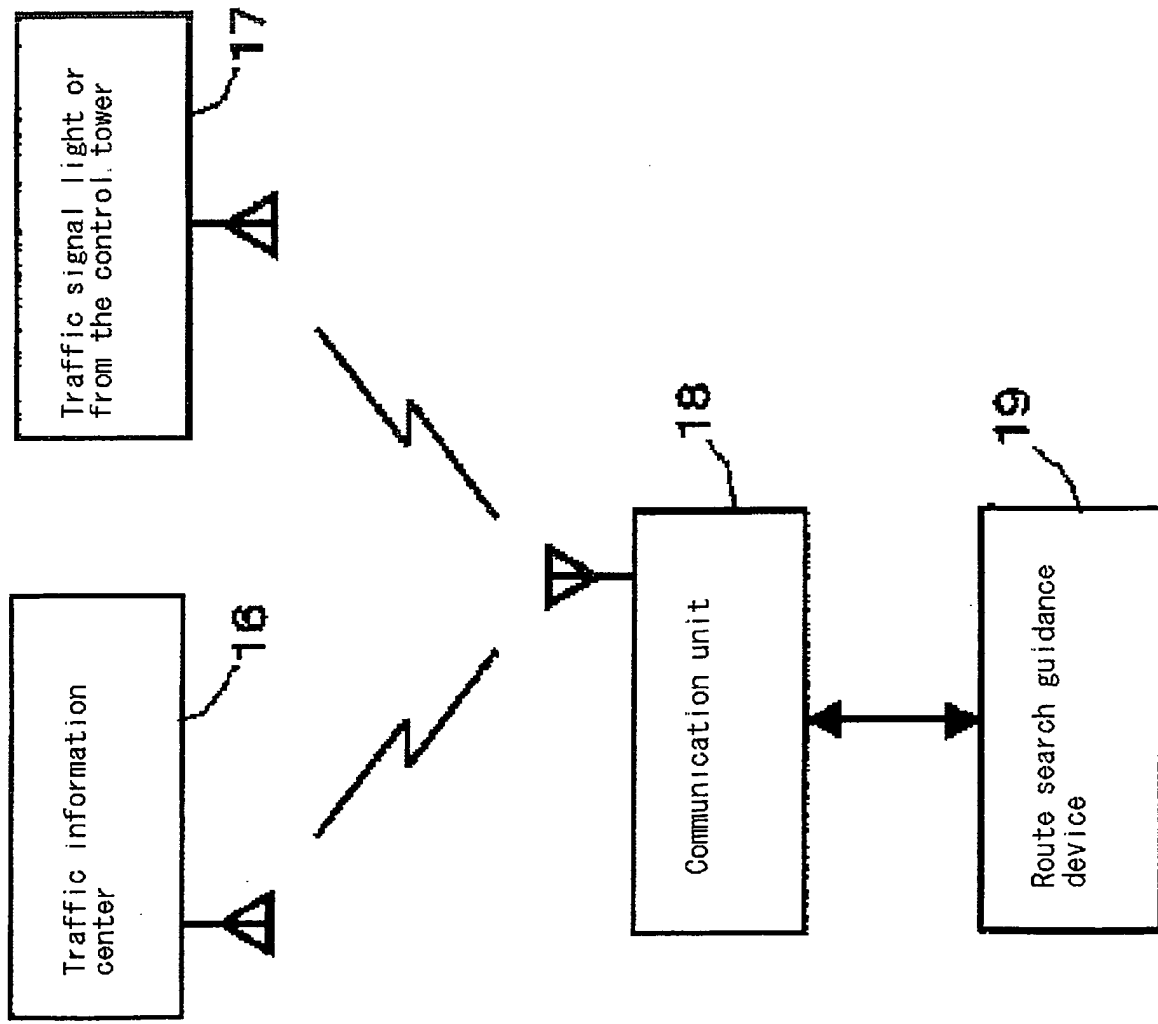


FIG021.GIF

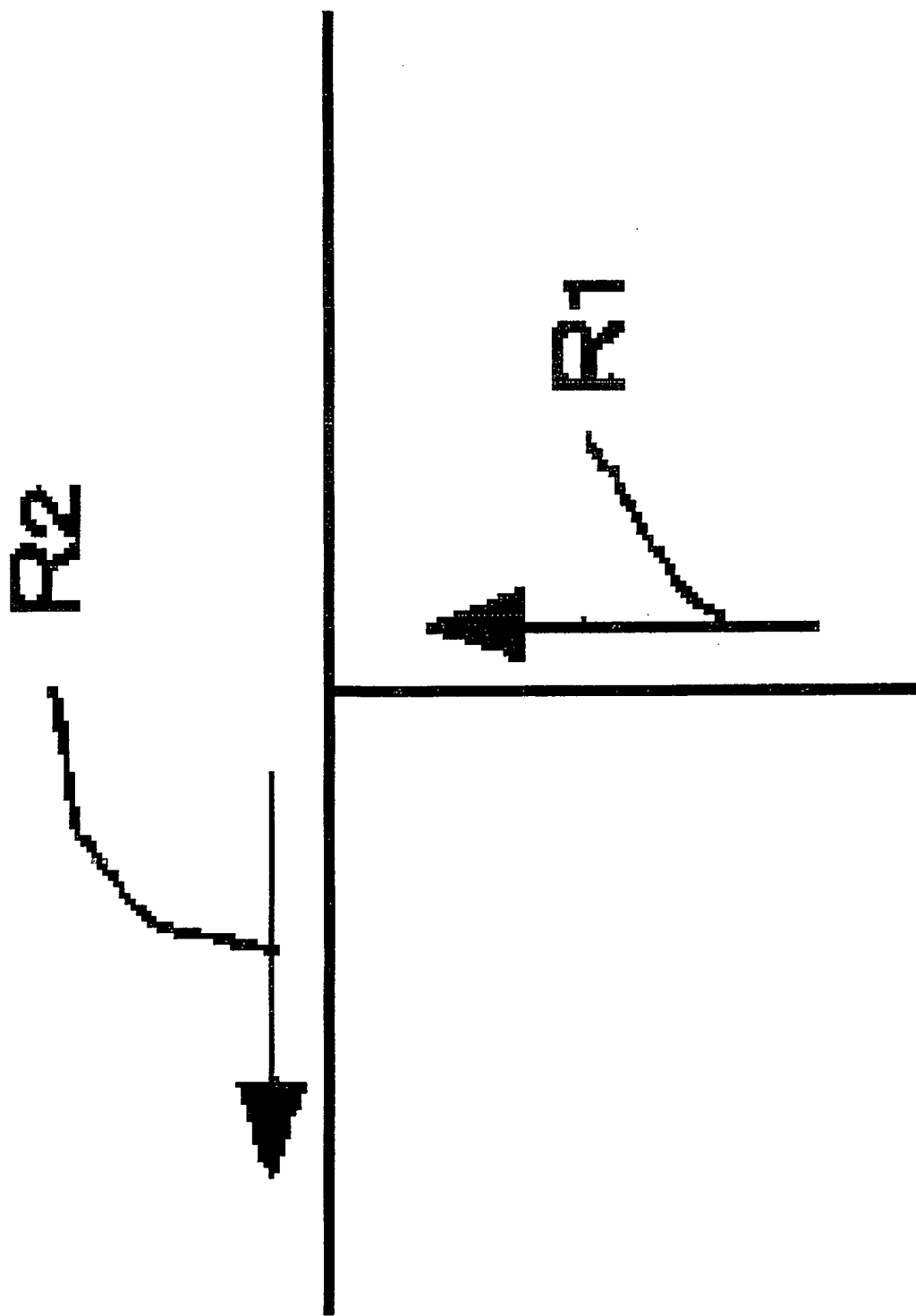


FIG022.GIF